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Final Long-term Monitoring Protocol for Rocky Intertidal Communities of Redwood National and State Parks, California

Natural Resource Report NPS/KLMN/NRR—2008/034

ON THE COVER
Rocky Intertidal area at False Klamath Cove, Redwood National and State Parks.
Photograph by: Cara McGary

Long-term Monitoring Protocol for Rocky Intertidal Communities of Redwood National and State Parks, California

Natural Resource Report NPS/KLMN/NRR—2008/034

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This protocol is available from the Klamath Network web site (http://science.nature.nps.gov/im/units/klmn/index.cfm).

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Note: This Rocky Intertidal Monitoring protocol is written to National Park Service standards. This protocol is designed for long-term monitoring of target algae and invertebrate species in rocky intertidal habitats using permanent quadrat and transect sampling methods. The selection of monitored sites in the Redwood National and State Parks (RNSP), Del Norte County, has been performed in a preliminary study. This Protocol Narrative and the associated Standard Operating Procedures are based on a successful preliminary study that was conducted in 2004-2005 at RNSP, as well as a broader monitoring program that is in existence at over 80 sites within California and Oregon. This narrative describes existing and previously tested protocols in full.

NPS D-216, March 2008

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Long-term Monitoring Protocol for Rocky Intertidal Communities of Redwood National and State Parks, California

Abstract

Long-term monitoring of the rocky intertidal marine resources within the Redwood National and State Parks (RNSP) was initiated in 2004 at three sites: Damnation Creek, False Klamath Cove, and Enderts Beach Cove. During a preliminary study conducted from 2004-2005, protocols were tested and refined for monitoring these sites. Monitoring was designed to identify and follow trends in population dynamics of selected indicator organisms. The monitoring involves biannual sampling of permanent photoquadrats, ochre star (*Pisaster ochraceus*) plots, and surfgrass (*Phyllospadix spp.*) transects. Monitoring of RNSP sites occurs in conjunction with an existing intertidal monitoring network comprised of various government agencies, universities, and private organizations. This network samples sites from northern Oregon to southern California, with the RNSP intertidal monitoring sites filling in a geographic gap in northern California. Sampling design and protocols for the RNSP sites have been adapted from this established and tested monitoring program (http://www.marine.gov/). Data will be used to describe seasonal and annual community changes, as well as to explore broader spatial and temporal scales. The proposal for RNSP rocky intertidal monitoring is for a rigorous, park-based approach that integrates with a long-term, spatially extensive program. The national parks are promoting the importance of marine resources by establishing long-term monitoring programs supported by the public and scientific community. This will translate into a better appreciation for these resources and an awareness of the importance of maintaining them for future generations.

Background and Objectives

Background and History

The coastline of northern California is home to a diverse array of nearshore habitats that contain a wide variety of species. Geographic location, habitat diversity, and complex oceanographic patterns contribute to the rich diversity of marine life in this area. The northern coastline of Redwood National and State Parks (RNSP) is primarily composed of rocky intertidal areas dominated by boulders and rocky bench areas. In recognition of intertidal communities being a potential vital sign for monitoring, the Klamath Network and RNSP began working with researchers from the Multi-Agency Rocky Intertidal Network (MARINe) program to undertake field testing of a monitoring program based on a well established protocol. In 2004, we initiated the intertidal pilot monitoring study in this region. The approach was to field test the protocol at RNSP to determine the adequacy of sampling locations and the budget. The major focus of this study was to provide an account of the algal and invertebrate communities found in the rocky intertidal habitats of RNSP and to describe the patterns of variability of the abundant and ecologically important species (Cox and McGary 2006).

Prior to this study, biological assessments had not been conducted in Redwood National and State Park's rocky intertidal since the late 1970s (Boyd and DeMartini 1977). Preliminary site-specific comparisons between the current assessment (Cox and McGary 2006) and those made by Boyd and DeMartini (1977) indicate a strong successional shift from a highly disturbed community to a more stable, late successional community. Percent cover variation has also decreased since the earlier study periods. These community differences may be attributed to the historically increased sediment loads and higher quantities of driftwood at rocky intertidal sites (McGary 2005). Without monitoring data before and after the years of intense logging, it is not possible to directly assess the impacts of increased sediment loads and driftwood scouring intertidal communities. This highlights the need for continued monitoring.

In the event that degradation was to occur from natural or anthropogenic drivers, monitoring data would enable managers to assess the impacts and determine biological responses (Raimondi et al. 1999). However, these assessments would be limited if monitoring was restricted to the rocky intertidal areas within RNSP. A common problem for field monitoring programs is separating the natural limits of variation within a system from abnormal (e.g., human disturbances such as logging or oil spill) conditions (Murray et al. 2006). Determining natural variation in intertidal communities is especially challenging due to the highly dynamic nature of this system. Natural processes acting on a local scale, such as local freshwater input, cannot be separated from local human disturbances. This highlights the value of linking park-based monitoring with regional scale efforts.

The importance of establishing a long-term regional monitoring program of marine resources has been recognized by many organizations. Minerals Management Service (MMS) and Partnership for the Interdisciplinary Studies of Coastal Oceans (PISCO) have been working in concert with over 20 coast-wide academic and government organizations to conduct intertidal monitoring in the form of Community Dynamics Surveys along the coast of California. This network, the

Multi-Agency Rocky Intertidal Network (MARINe), was founded in 1997 in response to the need to standardize and synthesize ecological data from the various monitoring programs. In order to provide the most robust and cost effective regional dataset for the assessment of intertidal health and trends along California's rocky shores, independent long-term ecological monitoring programs were called together to unify and collaborate. Through the standardization of data collecting methods, MARINe now jointly coordinates and shares data from partnered organizations through an integrated database and unified sampling protocol (Engle et al. 1994 and Engle 2005). Partners in the network have conducted surveys to determine abundance and distribution patterns of intertidal species along the southern California coast since the 1990s and have more recently expanded into central and northern California and even into Oregon. The focus of these surveys is to examine temporal changes within permanent study plots. We have adapted the protocols used in these surveys for monitoring intertidal organisms within Redwood National and State Parks.

The National Park Service, within its nation-wide Inventory and Monitoring (I&M) Program, has recognized the value of long-term monitoring programs (NPS 1995). Based on protocols established at Channel Islands National Park (CINP) (Richards and Davis 1988), a monitoring program for the tidepools of Cabrillo National Monument (CABR; in San Diego, CA) was established (Engle and Davis 1996; Becker 2006) in the early 1990s; a program is underway in Golden Gate National Recreation Area (GGNRA). These parks have partnered with MARINe to establish comparable datasets of their marine resources (Davis and Halvorson 1996, 2005). The proposed intertidal monitoring for the RNSP sites follows the same protocols and procedures as the CINP, CABR and GGNRA programs and will utilize the same database. This will allow comparisons of population dynamics to be made with sites throughout the state. The addition of sites within RNSP fills a noticeable gap in the geographic coverage of existing community surveys. Prior to this addition, no intertidal monitoring sites existed between southern Humboldt County, California, and southern Oregon, a gap of over 200 km.

Intertidal monitoring at RNSP can be linked to management. Although coastal national parks often do not have jurisdiction below the mean high tide line and are limited in their management practices that influence the low tide areas, RNSP does have some management jurisdiction below mean high tide line. The following language is an abbreviated excerpt from an internal briefing statement on park submerged lands (National Park Service Report 2006a).

The Redwood National Park boundary extends ¼ mile into the Pacific Ocean in Humboldt and Del Norte counties, for the entire 35 mile length of the park. However, federal land ownership extends seaward only to the mean high water mark; west of that line, the intertidal and submerged lands remain in state ownership. Although the NPS has generally exercised jurisdiction over those submerged lands and ocean waters since the park was established in 1968, questions have arisen periodically over the NPS' authority and ability to protect resources and manage public use on those lands and waters. In order to resolve such authority and jurisdictional issues and to facilitate and enhance the protection of all resources located within the park boundary, regardless of land ownership, in 1990 the NPS submitted an application to the California State Lands Commission to lease the state-owned submerged lands within the park boundary.

The California State Lands Commission approved the NPS application at its quarterly meeting of January 30, 2002, and issued a lease to the NPS on March 22. The term of the lease is 49 years, expiring December 31, 2050. The lease covers the state-owned submerged lands from mean high water mark to a point 1,000 feet seaward for the entire length of the park, with a few minor exclusions. The NPS will manage the resources and public use in this area in accordance with the General Management Plan for Redwood National and State Parks, approved in 2000.

Rationale for Selecting this Resource to Monitor

The rocky shores of the west coast of North America are among the most diverse marine regions in the world. They offer a great opportunity for learning and recreation, as they are the most accessible marine areas for human use. Few studies have focused on the intertidal communities of northern California. Fortunately, studies suggest that the intertidal areas in central and northern California regions are still relatively undisturbed (as opposed to southern California) (Roy et al. 2003). Deterioration of these relatively pristine intertidal habitats can happen rapidly, making the establishment of a baseline assessment and continued monitoring program of these resources critical. Monitoring will allow us to identify trends inconsistent with the baseline conditions and natural variation. A monitoring program is necessary to assess the continued status of the rocky shores and address current and future impacts.

The national parks are responsible for establishing a baseline assessment of their coastal marine resources and then to monitor those resources that are deemed most important (Richards 2000). This involves ranking the various coastal resources, in order to prioritize monitoring efforts. Intertidal communities consistently ranked among the top ten potential vital signs among all resources evaluated by the Klamath Network in its scoping process (Sarr et al 2007). (Note: the specific rank depended on the weighting of management and ecological significance and monitoring costs and feasibility.) Currently, the only marine resources that the Klamath Network proposes to monitor are intertidal communities. The Klamath Network has also identified keystone species as important vital signs to monitor (Sarr et al 2007). A textbook example of a keystone species occurring in west coast intertidal systems is the ochre sea star (*Pisaster ochraceus*) (Paine 1969). Ochre sea stars are one of the species that will be monitored under this protocol. Finally, the Klamath Network ranked non-native species as its most important vital sign (Sarr et al 2007). The only monitoring of potential invasions of non-native species into marine environments of the Klamath Network is through the intertidal community monitoring. While non-native species are not currently a serious problem in the marine intertidal at RNSP, the habitats could be susceptible to future invasion. The intertidal monitoring program provides a mechanism for early detection of invasive species within the rocky intertidal habitats surveyed.

Population monitoring within the rocky intertidal provides baseline information essential for detection, assessment, and study of the short and long-term effects of natural disturbances such as severe storms, flood events, and tsunamis, as well as anthropogenic disturbances such as visitor use impacts and oil spills. Monitoring also provides fundamental ecological knowledge of system dynamics. For instance, the abundance and distribution of major algal species (*Pelvetiopsis, Endocladia, Fucus*) and invertebrate animals, such as barnacles (*Chthamalus, Balanus*) and mussels (*Mytilus*), at RNSP are likely to change in response to both natural and human-caused events. These structural changes, in turn, are likely to affect the abundances of

motile species, such as sea stars (*Pisaster*) and a host of native crabs and snails. When incorporated on a regional scale, monitoring studies can also be utilized to plan more effective management strategies (Miner et al. 2005).

This project will provide a wealth of baseline and monitoring information about intertidal communities that park managers can then use to develop outreach mechanisms. Local management strategies may include forming interpretive tools and educational outreach programs. Any future management decisions regarding coastal access or marine resource restrictions will also rely on the intertidal monitoring program. The MARINe protocol has been used in other parts of California to document disturbance events associated with the El Niño Southern Oscillation (Miner et al. 2005), population declines resulting from disease and over-harvesting (Raimondi et al. 2002), and invasions by non-native species (Miller et al. 2007). These examples demonstrate that this is an effective manner of monitoring intertidal communities. Using the MARINe protocols also allows us to make broad scale geographic comparisons; data from sites within Redwood National and State Parks are directly comparable with data collected from over 80 sites from southern California to northern Oregon.

Monitoring intertidal communities is critical for making informed management decisions. Tracking changes in these communities allows determination of "normal" limits of variation, as well as seasonal and long-term patterns. Understanding these patterns is necessary for detecting anthropogenic changes resulting from climate change or disturbances such as oil spills. As was learned from the Exxon Valdez oil spill in 1989, accurate baseline information about intertidal communities is paramount for determining appropriate clean-up and restoration procedures (Paine et al. 1996; Peterson et al. 2003; Sharman et al. 2004). Rocky intertidal organisms are assumed to live very close to their thermal tolerance limits (Wethey 1983; Bertness et al. 1999). For this reason, many studies have suggested that climate change may have strong effects on the distributional patterns of intertidal organisms (Fields et al. 1993; Barry et al. 1995, Sagarin et al. 1999; Smith et al. 2006). Reports produced from this study will address the corresponding climate variability during the study period. Using temperature loggers (SOP #11: Temperature Loggers) and available oceanographic models, it may be possible to determine if species range shifts can be explained by climate data. Once species ranges are established for a region (e.g., northern California), it may be possible to forecast effects of decadal and seasonal scale climate change on the geographic distribution of ecosystem foundation species and to test the forecasted hypothesis with long-term monitoring data.

It is also necessary for the baseline data to be appropriate to the scale of the anthropogenic disturbance event. Having site-specific monitoring data is important; however, managers must also know what resources exist throughout the region and the natural spatial and temporal variation thereof (Schoch and Dethier 1996). The site-specific monitoring data need to be put into context of a larger spatial scale and related to other similar locations. Joining the Multi-Agency Rocky Intertidal Network provides the larger context, to help interpret natural variability at a site level.

While arguably one of the greatest benefits of long-term monitoring is documenting community response to known natural or human induced phenomena, additional value comes from having researchers consistently present in the field so that we may opportunistically capture events that

would otherwise be missed (Miner et al. 2005). An additional benefit of long-term monitoring work is that researchers become familiar with the composition and abundance of species at a site and are thus more likely to notice if a new species invades or if particular species increase or decrease in abundance.

The marine monitoring is like the canary in the mine, to signal abnormal situations. If the monitoring results show large negative or positive changes, it should trigger park management and resource personnel to investigate the causes of the changes (whether natural or human caused). For example, if they are negative and human related, those activities should be restricted or modified (e.g., tidepooling, harvesting mussels or limpets, and shore fishing). Management practices may include restricting access to sensitive areas or by creating in-park regulations. Where the parks do not have the authority, cooperation with state (e.g., California Department of Fish and Game) or federal agencies may be necessary. The parks may also employ the process through the Federal Register to promulgate new regulations or make changes.

Another result of the intertidal monitoring is uncovering patterns that may lead to additional research. For example, the preliminary intertidal monitoring at RNSP made the initial discovery of juvenile black rockfish utilizing tidepools (Cox and McGary 2006). This resulted in subsequent research to further explore the subject and illustrated the role of the intertidal habitat in the life history of a commercially important fish species (Cox and McGary 2006).

The coastal parks have an obligation to monitor their marine resources. Without monitoring that provides data on the status of these resources, informed management decisions cannot be made with accuracy. Such is the case in the decision process to set aside marine protected areas (MPAs) in California. Monitoring data are necessary to illustrate the importance of the intertidal areas and to lobby others who will be making the decisions of where to locate MPAs within the park. Marine data are extremely limited for the northern California region; the process of establishing MPAs in this region will undoubtedly look at data from this study.

Currently, southern and central California are leading the discussion and designation of MPAs within California, but, as we gain insight into the future of our marine resources, establishing protected areas and reserves will soon become a reality in the more remote stretches of northern California coasts. Intertidal monitoring conducted by MMS and PISCO is laying the groundwork for the California MPAs and shaping the program. Data collected at intertidal sites monitored by these groups have been used to delineate subregions for conservation. The issue of MPAs and reserve establishment is often shrouded in mistrust and misunderstanding by local interest groups, such as both commercial and recreational fishermen. This is often fueled by lack of scientific-based knowledge to back the claims of the importance and benefits of these proposals. Creating and maintaining a sound monitoring program will provide evidence to help managers and scientists determine the future need for enhanced protective status for these parks.

Measurable Objectives

Monitoring Objectives:

- Monitor the temporal dynamics of target invertebrate and algae species (listed in Appendix E) and surfgrasses across accessible, representative, and historically sampled rocky intertidal sites at Redwood National and State Parks that can feasibly be monitored with the Network's intertidal monitoring budget ($30k/yr) to: 1) Evaluate potential impacts of visitor use or other park-specific activities; and 2) Provide monitoring information to help assess level of impacts and changes outside normal limits of variation due to oil spills, non-point source pollution ,or other anthropogenic stressors that may come from outside the parks.

- Determine status, trends, and effect sizes (as applies) through time for morphology, color ratios, and other key parameters describing population status (e.g., size, structure) of the selected intertidal organisms.

- Integrate with and contribute to a monitoring network spanning a broad geographic region, in order to evaluate trends at multiple scales, from the park to region-wide, taking advantage of greater sample sizes at broader scales.

- Detect and document invasions, changes in species ranges, disease spread, and rates and scales of processes affecting the structure and function of rocky intertidal populations and communities to better understand normal limits of variation.

Measurement and Analysis Objectives:

- Provide a fine-scale photographic record of sessile invertebrates and algae (and potentially oil and other non-point source pollutants) using fixed plots (photoplots) as reference.

- Determine percent cover of organisms within select fixed plots in the field as time and tide levels allow. These are the same fixed plots (interchangeably called photoplots or photoquadrats) that are photographed in the field.
- Use field sampling to determine relative densities of snails, chitons, limpets, and crabs (mobile invertebrates) that may serve as an indicator of overall or specific ecosystem health.

- Determine changes in surfgrass abundance by measuring cover along fixed point-intercept transects.

- Identify trends inconsistent with the established baseline conditions, whether they are park-specific or broader in occurrence and whether there are potential management actions to mitigate them.

- Prepare annual summary reports and five year, peer reviewed trend analysis reports showing data relevance following Park Service Reporting guidelines. Reports will display any major (>50%) changes in the abundance of target taxa between sampling intervals as a highlight for potential management actions.

Sampling Design

Rationale for Selecting this Sampling Design over Others

Sampling of the three rocky intertidal sites in Redwood National and State Parks follows the protocols described in Engle (2005), which are modeled after methods used by the CINP intertidal monitoring program (Richards and Davis 1988) and Minerals Management Service (Ambrose et al. 1995). The protocols focus on sampling fixed plots of target species or assemblages (Appendix E). A fixed plot sampling design provides data about changes within the plot over time and reduces the variability in those data, unrelated to temporal trends (Murray et al. 2006). Implementing this sampling design provides a collaboration opportunity with MARINe, an established and well tested monitoring network. The MARINe network, encompassing sites from San Diego to northern California, Oregon, and the Channel Islands, as well as those proposed in the RNSP, is the longest running, large scale intertidal monitoring program on the west coast of North America.

There is a long-standing debate in the literature about fixed versus random sampling, listing numerous pros and cons of both methods (Murray et al. 2006). Sampling with fixed plots reduces confounding temporal variation, whereas random sampling reduces confounding spatial variability. Both methods have strong statistical models and approaches. The argument really comes down to a question of feasibility and budget constraints. The more cost effective, fixed-replicate selection is efficient for tracking temporal change in specific assemblages. If budget were not a constraint, random sampling would be the preferred means to generalize over the greatest spatial context. However, the spatial variance for the intertidal monitoring is so large that random sampling is not feasible with the funding available. Unfortunately, masses of random replicates would be needed to monitor temporal change. In order to balance the realistic constraints of budget with the optimal amount of temporal change, multi-site fixed plot sampling has been shown to be the best solution.

The fixed plot design creates limitation on the amount of spatial inference that can be made. In order to increase the level of inference to surrounding areas and sites, this monitoring involves other types of larger scale sampling. For example, overview photographs are taken of entire zones within each site to put fixed plots into a broader site context. In addition, Coastal Biodiversity Surveys (CBS) are conducted to compliment the long-term monitoring program. The CBS quantify species' distribution and abundance across an entire rocky bench (UC Santa Cruz 2006). These surveys have been conducted at Damnation Creek at RNSP (Cox and McGary 2006). Much of the broader scale data collected is intended to be ancillary data that will not be analyzed until the need arises. For instance, in the event of an oil spill, this information is available to put the monitoring data in a larger spatial context.

Repeated sampling with a fixed plot design is used by many other large scale monitoring programs. The Long-Term Ecological Research group (LTER), established by the National Science Foundation (NSF), uses fixed sampling as a model for their network's research. Forest Inventory and Analysis (FIA) surveys have provided forest inventories for 13 states since 1933. The FIA uses repeated samples of panels (or fixed plots). Statisticians have shown that analysis

of data from the long-term repeated surveys lead to a better statistical inference than one-time inventories (Reams and Van Deusen 1999).

Past efforts directed at monitoring intertidal patterns have been compromised because of variation in sampling design, sampling effort, and sampler expertise. The protocols for the MARINe Community Dynamics Surveys use identical sampling in terms of design, effort and expertise at all sites (Minchinton and Raimondi 2001). This consistency provides the ability to track changes at an ecosystem level. The collective monitoring effort by MARINe addresses questions related to biogeography, effects of human use, management of coastal resources, and conservation along the temperate west coast of North America. The data resulting from this work allow us to evaluate temporal and spatial community dynamics in both the short and long-term. This information is essential for assessing impact due to natural or human induced disturbance (see Raimondi et al. 1999 for examples of both), as well as understanding biological community response to important physical phenomena, such as inter-decadal changes in sea surface temperature (McGowan et al. 1998).

Data collected will provide both local insights into marine resources and regional comparisons. The benefits of this collaboration include the following (from Engle 2005):

- Increases reliability, efficiency, and cost-effectiveness of programs.
- Increases cooperation and communication among agencies and organizations.
- Enhances long-term support to ensure continuity of sampling.
- Provides opportunity for identification and rectification of data gaps.
- Allows more timely access to standardized data by all users.
- Integrates information for efficient analysis, synthesis, and reporting.
- Permits evaluation of large-scale spatial and temporal patterns.
- Facilitates periodic review of ability of monitoring to achieve goals.
- Expedites linkages to other relevant programs.
- Enhances public outreach and interpretation programs.
- Assists in designing and critiquing restoration programs for impacted resources.
- Aids in framing research questions regarding cause and effect relationships.
- Increases public awareness of knowledge-based environmental management.
- Provides a cadre of trained biologists capable of rapid response to impacts.

Site Selection

Criteria for Site Selection:

The sites for rocky intertidal monitoring at RNSP were selected with the assistance of resource management staff at the park, based on accessibility, budget limitations, and the following criteria (adapted from Engle 2005):

- Areas previously surveyed or monitored that provide historical data.
- Unsurveyed areas representing major data gaps.
- Areas of concern with regard to human impacts, including potential oil spills.
- Areas with relatively pristine habitats.
- Areas with species assemblages and ecological conditions representative of the northern California coastline.

- Areas that provide habitat for sensitive or rare intertidal species.
- Areas with optimum conditions for long-term monitoring.

Optimum conditions for monitoring include reasonable and safe site access, adequate bedrock surfaces for establishing permanent plots, sufficient abundance of key species, and minimal disturbance to sensitive resources (e.g., seabird colonies, marine mammals).

The RNSP marine areas host a diverse array of habitats, including sandy beaches, cobble beaches, boulder fields, rocky benches, cliffs, and estuaries. This proposal focuses on rocky intertidal areas within the park. The amount and distribution of bedrock habitat within RNSP is being quantified by a coastal inventory project through a cooperative agreement with Humboldt State University and the National Park Service (Craig et al. 2006). This assessment of the habitat and vegetation types of the RNSP coastline is intended to enhance the physical data available for this coastline. The one time habitat study will help to place the proposed long-term monitoring program in a larger spatial context within RNSP.

Rocky benches are the only habitat type proposed for the intertidal sampling. These sites provide the greatest species diversity and best opportunity to track the established "vital signs" along the RNSP coastline. Establishing rocky intertidal sites also allows for comparisons to be made with similar study sites along the Pacific west coast. Fewer, comparative studies exist for other coastal habitat types. Sandy beach sites were sampled in the preliminary RNSP sampling study (Cox and McGary 2006) and have been sampled at Channel Islands National Park (Dugan et al. 2000) and Olympic National Park (OLYM) (Dethier 1997). However, inclusion of sandy beach sampling in the RNSP intertidal monitoring protocol was deemed a lower priority when "vital signs" and budget considerations were assessed. The site and seasonal variation in sandy sites was so high in both biological and physical parameters that obtaining statistically worthwhile data would require extensive sampling. This habitat is also relatively species poor compared to rocky habitats. Cobble beaches are also not included in the monitored sites because most of the organisms live under the cobble; feasible methods for monitoring them have not been developed. Boulder fields are not sampled for similar reasons. OLYM, in Washington State, attempted cobble and boulder field sampling with their intertidal monitoring program. The current proposed protocols for the intertidal monitoring program at OLYM recommend avoiding monitoring of mixed-coarse (cobble) and boulder habitat communities (Fradkin 2005). This report states that "These highly disturbed habitats are physically complex, making them difficult to sample in a reliably quantitative fashion. Preliminary work in these habitats suggests that diversity and abundance data are highly variable in space and time, likely due to the patchy, dynamic nature of these habitats." The estuarine habitats at RNSP are already being monitored by the park and coastal cliff sites were not included due to obvious access limitations.

Oil coverage from the Alaska (Exxon Valdez) and recent California oil spill (Cosco Buson) did not seem to discriminate against intertidal habitat type, although an accumulation of oil was noted on prominent rocky shores (points). In the event of an oil spill along the Pacific coast, there are established emergency protocols that include a range of coastal habitats (sandy beach, rocky bench, and boulder fields). The same researchers that conduct the MARINe style intertidal monitoring program are trained in these emergency protocols. The emergency protocols are designed to enhance the ability of the existing monitoring program to assess oil spill damage.

This cooperative pre and post-spill sampling has been used to assess effects of the southern California Torch Oil Spill (Raimondi 1999) and for the recent San Francisco, California Cosco Buson spill in 2007. Establishing the intertidal long-term monitoring program for RNSP will provide the comparative data necessary to assess a potential oil spill in this region.

Procedures for Selecting Site Locations:

Aerial photographs and site maps were used to select potential intertidal sampling sites. Limited, accessible, rocky intertidal areas exist within the boundaries of RNSP. Site selection required visiting all accessible intertidal areas to find sites that fit the above criteria. We used a modified stratified random selection process for selection of sites. This led to a series of sites that spanned the range of rocky intertidal area within the park boundaries. The Multi-Agency Rocky Intertidal Network employs this method to select sampling sites throughout California. Analysis has demonstrated that the monitored sites can be used to extrapolate information to surrounding rocky intertidal areas and that there is good agreement between monitored sites and other surrounding sites (Minchinton and Raimondi 2001). Channel Island National Park's kelp forest and intertidal monitoring programs established fixed monitoring sites using a similar stratified random approach because the primary purpose of the program was to measure change over time, not to make population estimates for the entire park (Davis 2005). Fixed ecological monitoring sites are established so that changes in parameters reflect changes over time and are not confounded by within-site variation.

The three sites chosen fit the above criteria span the rocky intertidal area within the park. A site consists of a rocky intertidal bench at least 30 m wide that is representative of the surrounding area. Plots within each site have been established in particular assemblages of target species (SOP #3: Establishing and Maintaining Plots).

Number and Location of Sites

Taking into account the above mentioned site selection criteria and the range of the intertidal within RNSP, three rocky intertidal sites were selected for monitoring within the park. The selected sites are Enderts Beach, Damnation Creek, and False Klamath Cove (Figure 1). The sites are approximately 5 km apart and span the 17 miles of rocky intertidal present in the RNSP.

Enderts Beach (N 41.69592, W 124.14245) is at the northern edge of RNSP, located at the south end of Crescent Beach. The site is comprised of a large, gently sloping bench (approximately 100 m wide) and a series of three smaller benches separated by rocky trenches and cobble beds. Rocky intertidal monitoring occurs on the three rocky benches.

Damnation Creek (N 41.65249, W 124.12784) is 5 km south of Enderts Beach and 6.5 km north of False Klamath. It is an extensive rocky bench cut by channels, with a few large sedentary boulders at its seaward edge. The landward edge of the bench has an accumulation of smooth cobble. The site is near the mouth of Damnation Creek; however, monitoring plots are established on either side of the creek's outflow, far enough away to avoid freshwater input.

False Klamath Cove (N 41.59377, W 124. 10773) is located just south of Wilson Creek, about 8 km north of the Klamath River mouth. This site has variable substrata that range from coarse

sand to large boulders. There is potential for temporal variation in sand scour and boulder movement. The intertidal study site is peninsula-like with the ocean to the north and south and a sea stack (approximately 75 m tall and 100 m wide) at the west end. The peninsula stretches approximately 250 m long with a width of approximately 100 m. It is a gently sloping field of boulders and small rock benches. Sampling is restricted to large sedentary boulders and small rocky benches.

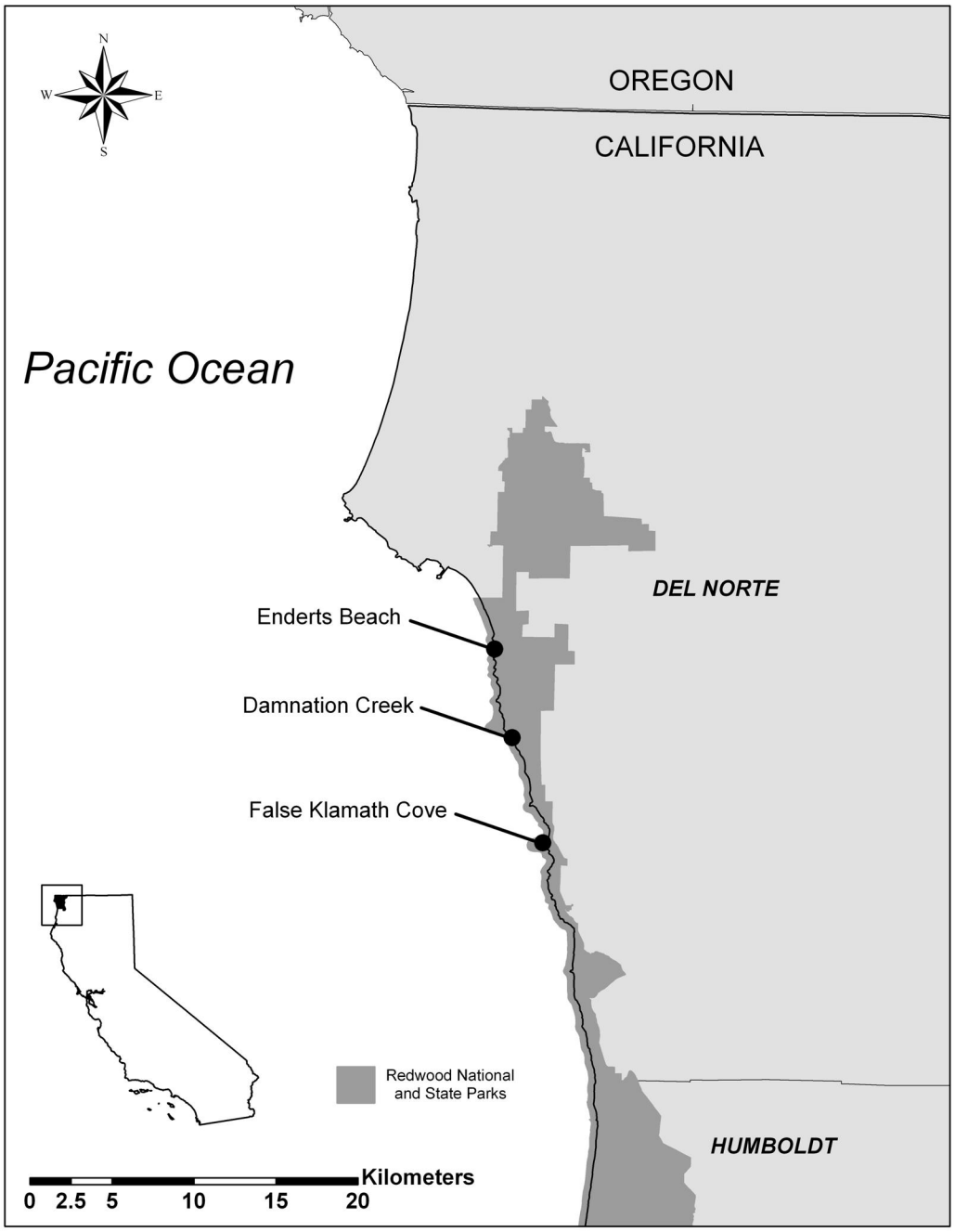

Figure 1. Map of northern Redwood National and State Parks, showing locations of rocky intertidal study sites.

Sampling Frequency and Replication

The rocky intertidal sites are sampled twice annually (summer and fall/winter), using fixed plots in target community assemblages and overview photographs to place the fixed plots in a broader spatial context. Fixed plots allow the dynamics of rocky intertidal species to be monitored with reasonable sampling effort. Targeting key species or assemblages allows the sampling effort to focus on ecologically important components of the assemblage and provides greater power to detect changes over space or time. Replication comes from individual quadrats, plots, or transects at a given site and sample period.

Using the MARINe protocols (Engle 2005), site overview assessments (SOP #5: Photographing Plots and Taking Area Photos), permanent photoplots (SOP #3: Establishing and Maintaining Plots), and sea star plots (SOP # 9: Sea Star Monitoring) were set up at False Klamath Cove, Damnation Creek, and Enderts Beach in 2004. A pair of surfgrass (*Phyllospadix*) transects were also established at Damnation Creek in 2004 (SOP #10: Surfgrass Monitoring). The photoplots record changes in the cover of certain populations, including mussels (*Mytilus californianus*), barnacles (*Chthamalus dalli/Balanus glandula*), and three species of algae (nailbrush seaweed [*Endocladia muricata*], rockweed [*Pelvetiopsis limitata*], and dwarf rockweed [*Fucus gardneri*]). These five species were chosen for monitoring because they are conspicuous, bed-forming, abundant, and ecologically important. The dwarf rockweed was not dense and continuous enough at Enderts Beach, nor was there enough dense rockweed at Damnation Creek when the study was initiated, to merit plot establishment for those species at those sites. Except for these, each target species type is monitored in five replicate plots at each site, with one further exception (Table 1). At Damnation Creek, five additional mussel plots are sampled. These plots are located in the outflow of Damnation Creek, where salinity is often much lower than in the other mussel plots (Cox and McGary 2005).

Three irregular plots were established at each RNSP intertidal site to sample ochre sea stars (*Pisaster ochraceus*). Recording size and color information for ochre sea stars gives us an indication of population structure at the various sites and enables us to determine which sites receive the highest levels of recruitment and contain the largest individuals.

Table 1. Photoplot type and number of replicates at each RNSP site. NP= No plots.

	Common Name	Mussels	Barnacles	Rockweeds/Sessile algae		
Site	**Scientific Name**	*Mytilus spp.*	*Chthamalus, Balanus*	*Pelvetiopsis limitata*	*Endocladia muricata*	*Fucus gardneri*
Damnation Creek		10 plots*	5 plots	NP	5 plots	5 plots
False Klamath		5 plots	5 plots	5 plots	5 plots	5 plots
Enderts Beach		5 plots	5 plots	5 plots	5 plots	NP

*Five mussel plots are located away from creek outflow and five plots are located near the outflow of Damnation Creek.

Timing of Field Sampling

The sampling at each site is timed to correspond to seasonal low tide series. A spring/summer sampling event occurs between May and June and a fall/winter sampling event is attempted between November and January. Tidal schedules dictate the precise timing of sampling. Summer sampling occurs during morning tides and the fall/winter sampling occurs during afternoon tides. Ocean conditions must be monitored closely prior to sampling and during the winter months, when rough seas may occasionally prevent sampling.

Most of the plots can be sampled at a -0.5 feet or lower tide, but most transects and mussel plots require tides that are -1.0 feet or lower. Sampling dates will be scheduled on the lowest possible tides of the season with at least a -1.0 tide. Sampling will start two to three hours before the low tide (earlier for lower tides), to perform work as the tide is going out. When choosing dates, field personnel check sunrise or sunset times to estimate the actual amount of daylight work time. Sampling can begin or end in the dark but is most efficiently performed during daylight hours (SOP#1: Pre-season Preparations).

Level of Change that can be Detected for Amount/Type of Sampling

Long-term monitoring of MARINe sites allows for assessment of change within intertidal communities on many levels (Minchinton and Raimondi 2005). The fixed plot sampling of targeted assemblages has high power to detect changes in the abundance of common intertidal species (Appendix B). Researchers using these sampling methods have documented naturally occurring seasonal variation, as well as longer-term fluctuations in the abundance of species (Miner et al. 2005). This record of species dynamics within sites has enabled scientists to assess damage and document recovery following human induced impact and natural disturbance. The existing MARINe monitoring program has produced what is, in terms of its spatial and temporal extent, one of the most comprehensive sets of data ever collected for species living in rocky intertidal communities.

A study was performed to examine the level of change that can be effectively detected by the temporal and spatial design of the current intertidal monitoring program. The purpose of this analysis was to determine whether modifications to the spatial and temporal aspects of the sampling design are necessary, so that future impacts may be reliably detected (Appendix B). The ability of the monitoring program to estimate the effects of impacts is demonstrated using power analyses with a Before-After design. Statistical analyses of the data revealed that the current sampling design and monitoring protocols have a great ability to show the natural limits of variation and to detect trends in the abundance of target species. This analysis suggested that this methodology is able to detect a 50% change in abundance with 80% power, a level that has been proposed as a reasonable goal for monitoring studies (Fairweather 1991). The study concluded that no changes should be made to the current monitoring program, but additional sites and target species should be added as resources permit.

The intertidal habitat is characterized by bands or zones of assemblages that have a high percent cover of a given species. The target species for each site are chosen based on the predominate

bands at the site. The protocols outline establishing plots with high (>70%) percent cover of a target species (SOP #3: Establishing and Maintaining Plots). Consequently, the initial monitored change commonly shows a dip in percent cover; however, this variation can be modeled out over time. This method of plot selection has been shown to have the best likelihood of picking up natural variation over time. The effectiveness of this sampling methodology has been shown in an oil spill assessment. Intertidal data collected during the Torch Oil Spill in southern California was compared to nearby MARINe monitored sites to assess the possibility of biological effects resulting from the spill (Raimondi 1999). Using models to tease out temporal trends and determine natural variation provided control sites for the oil spill assessment. Methods included a BACIP (Before-After Control Impact Procedure) test to examine if post-spill data from potentially affected sites differed from "expected" values. The "expected" values were based on pre-spill monitoring data from control sites located outside of the impact zone.

The purpose of summarizing these spatial and temporal trends was to examine changes in the structure and dynamics of the target species. Given the relatively long temporal series of data over a relatively large number of sites, it is possible to identify both short (e.g., seasonal) and long-term (e.g., El Niño events) changes in abundance over both local (e.g., sites separated by kilometers) and regional (e.g., sites separated by the biogeographic break at Point Conception) spatial scales. Because of the relatively large number of target species, it is possible to identify whether changes are species-specific or common across taxa. Investigating such spatial and temporal patterns of species abundance can help identify dramatic changes outside normal limits of variation and lead to considerable insights about the factors which might be responsible for such fluctuations (e.g., changes due to human impacts such as oil spills).

Field Methods

Field Season Preparations and Equipment Setup

Scheduling and logistical preparation should be arranged three to six months prior to sampling season (SOP #1: Pre-season Preparations). This will include travel and lodging arrangements. Field gear will be maintained and ready for use prior to sampling events. California Fish and Game scientific collecting permits will be maintained at all times as well as National Park Service scientific research permits. The RNSP headquarters will be notified prior to any sampling event to ensure that any special circumstances are taken into account (e.g., bird nesting or marine mammal presence). Batteries for drill, flashlights, and cameras should be charged prior to the first day of sampling.

A field notebook will be maintained that includes site maps, site overview photos, interplot measurements, GPS measurements, tidal heights, text descriptions, and multiple photographs for each plot (SOP #4: Completing Field Logs and Assessing Site-wide Species Conditions). This guide will help samplers with site and plot orientation and should be consulted often to avoid changes in plot orientation through time. It should be kept up to date with changes and additions. It will be the responsibility of the Lead Project Field Biologist to maintain the field notebook.

Sequence of Events during Field Season

Sampling of all sites will occur during the same low tide series, taking one to two days per site. At the beginning of each sampling period, all the plots should be found and marked with PVC quadrats (rectangles measured to the same size as the plot), oriented appropriately on each photoplot. Care should be taken not to disturb the plots or transects while finding and marking them, including disturbing vegetation. All fixed plots are marked with permanent markers. Photoplots are marked on three corners with bolts. All bolts are stainless steel hex bolts, anchored by a mound of marine epoxy (Z-Spar A-788 Splash Zone Compound, available at marine supply stores). Occasionally, plot markers may be buried beneath mussels or thick vegetation. A metal detector may be used to locate hidden bolts. Any broken or missing bolts should be repaired during each sampling period (SOP #3: Establishing and Maintaining Plots).

Once PVC quadrats are laid out at all of the permanent plots, the photographer should take pictures of the plots while another sampler draws a series of field notes for each plot. As soon as a plot has been photographed and drawn, researchers may begin the mobile invertebrate sampling within each plot. Sea star plots and surfgrass transects may not be accessible until close to low tide; they should be sampled as close to low tide as possible.

Details of Taking Measurements with Field Forms

A detailed explanation of sampling methods and field datasheets is given in SOPs #4-11. Sampling protocols and the latest version of these datasheets can also be found on the MARINe

web site (www.marine.gov). The following is a brief overview of field methods and should not be relied upon for sampling purposes. Permanent photoplots (75 x 50 cm) are established and marked by three permanent bolts in target assemblages, such as barnacles, mussels, turfweed, and rockweed (Appendix E). Cover of the major taxa within these photoplots is determined by point-contact photographic analysis. Plots are photographed with a digital camera (minimum 5.0 mega pixel resolution and 3x optical zoom) with strobe mounted on a 50 x 75 cm PVC photo framer, to ensure equal scale among plots. Photo plots are scored for percent cover of sessile species using a rectangular grid (10 x 10 units) of 100 evenly spaced points created on an LCD computer monitor using Adobe Photoshop (Figure 2). This grid is overlaid on the digital photos and switched on and off to determine what taxon is below each point. Different layers of algae are not scored separately, so the total percent cover is constrained to 100%.

In addition to percent cover measurements, small mobile invertebrates are counted within each permanent photo plot area (SOP # 8: Motile Invertebrate Counts). With the exception of burrowing organisms and amphipods, all mobile invertebrates are counted in the field within the 50 x 75 cm PVC quadrat. The quadrat is aligned with three plot marker bolts to ensure accurate replication. Species targeted in these plots include snails: turban snail (*Tegula funebralis*), unicorn snail (*Acanthina spp.*), dog whelks (*Nucella emarginata* and *Nucella canaliculata*), rock snail (*Ocenebra circumtexta),* and periwinkle (*Littorina spp.*); chitons: gould's baby chiton (*Lepidochitona dentiens*), rough chiton (*Nuttalina spp.*), and mossy chiton (*Mopalia spp.*); and marine crabs: striped shore crab (*Pachygrapsus crassipes*), hermit crabs (*Pagurus spp.*), and various limpets.

Permanent plots are also established for the large, motile ochre sea stars (*Pisaster ochraceus)* (SOP #9: Sea Star Monitoring). The ochre sea star sampling protocol includes measuring and recording color information within the designated plots. These protocols are employed at sites from southern California to northern Oregon for monitoring sea stars. Despite a large body of ecological and developmental biology information on ochre sea stars, few studies have rigorously examined color patterns or their causes across its geographic range. A recent analysis of ochre sea star data collected by the MARINe and PISCO programs show that the frequency of orange sea stars is approximately 20% with little variation across a broad latitudinal band (Raimondi et al. 2007).

Permanent, 10 m long line transects are used to estimate the cover of surfgrass (*Phyllospadix scouleri/torreyi*) and associated species (SOP #10: Surfgrass Monitoring). The transects are designed to sample a larger area by field scoring what occurs under 100 points spaced at 10 cm intervals along a 10 m tape stretched out between marker bolts. These point-intercept transects are established at Damnation Creek, one of the RNSP sites. This site was the only one found to have suitable cover of surfgrass for sampling.

A series of photographic pans are taken at set locations throughout the site. These overview photographs, along with field notes, are used to describe general conditions at the site and to document the distribution and abundance of organisms not found within the photoplots. Information about the physical conditions (e.g., water temperature), presence of marine mammals, birds, humans, and species conditions are recorded in the field log. Field log information and site reconnaissance characterization are recorded on the two page field log data

form. General site information is collected during each sampling trip with a standardized datasheet of categories. Completing the datasheet includes categorizing target species abundance, appearance, and recruitment, as well as recording general physical and biological conditions at the site. These observations, along with the habitat overview photographs, provide valuable perspective on site dynamics that aid interpretation of data from the fixed plots and transects. The complete protocol for the field log and site reconnaissance is in SOP # 4: Completing Field Logs and Assessing Site-wide Species Conditions.

Post-collecting Processing (Voucher)

An initial voucher collection of algal pressings and invertebrates resides with RNSP. Any future voucher collections will be done for identification verification only or by request from RNSP. When collecting specimens, the National Park Service Museum Handbook (NPS 2006b) will be referenced for the latest information on methodologies for collection, preservation, and storage of specimens.

End-of-season Procedures

At the end of each sampling day, photos are downloaded to the computer. The photoplots and overview photos should be promptly labeled to avoid confusion. File names should follow marine conventions outlined in SOP #12: Downloading Digital Photos and Phot Image Management. Photographs are organized and analyzed by a specialist (SOP # 7: Scoring Photoplots in Office (Using Graphical Software)). After each sampling trip, data will be entered into the database and gear will be maintained and replenished.

A. Enderts- Spring 2004

B. Enderts- Summer 2004

C. False Klamath Cove, June 2004

D. False Klamath Cove, October 2004

E. Damnation Creek Plot with 100 point grid overlaid on photo.

Figure 2. Example of photoplots taken from sites within the RNSP in 2004 (Appendix A). Photos A and B are of plots from different sampling periods showing change in species cover, over time. Photo E shows the photo overlaid with a 100 point grid (red points).

Data Handling, Analysis, and Reporting

Metadata Procedures

Metadata procedures for the Klamath Network are outlined in SOP # 13: Metadata Guidelines. The purpose of metadata is to archive the data, along with providing sampling specifics such as how, when, and who collected the data presented. An updated metadata interview will be filled out after each sampling season and submitted with the updated database version.

Cataloging the data collected from the Rocky Intertidal Monitoring Program will be a joint effort between the Project Lead Field Biologist and the Klamath Network Data Manager. Project Managers will be expected to submit a data dictionary and metadata interview form prior to the start of the first field season.

Overview of Database Design

A detailed user's guide for the database is provided in Appendix C with an overview in SOP #15: Data Analysis and Report Writing. In 2002-2003, the Southern California Coastal Water Research Project (SCCWRP) developed an Access database that contains all previous intertidal monitoring data and is used for data entry by all MARINe groups. The Channel Islands intertidal monitoring data are included in this database, as well as the established RNSP sites. The database has fully standardized data entry methods, and makes it possible to easily extract data from the entire network of MARINe sites.

The MARINe database is an event driven database, designed for the semi-annual MARINe surveys. Data collected during the surveys are recorded in one of three "results" tables (Figure 3). The correct result table to use is based on the method of observation used in obtaining the results. These sets of results are recorded for each site in the MARINe system (SOP # 15: Data Analysis and Report Writing; Appendix C).

Data Entry, Verification, and Editing

At the end of each field day, it is important to review the datasheets to look for omissions, errors, and illegible marks. Data from field forms are entered into a local copy of the MARINe database by a Biological Technician. After a series of quality control checks, these database records are uploaded into the main database. Uploading should occur after all data from each site have been entered for an entire season. Datasheets, maps, photographs, and computer files are managed as described for each survey method in the individual SOPs. Data entry, error checking and correction, and other data management procedures for the Access database are described in the SOP # 15: Data Analysis and Report Writing.

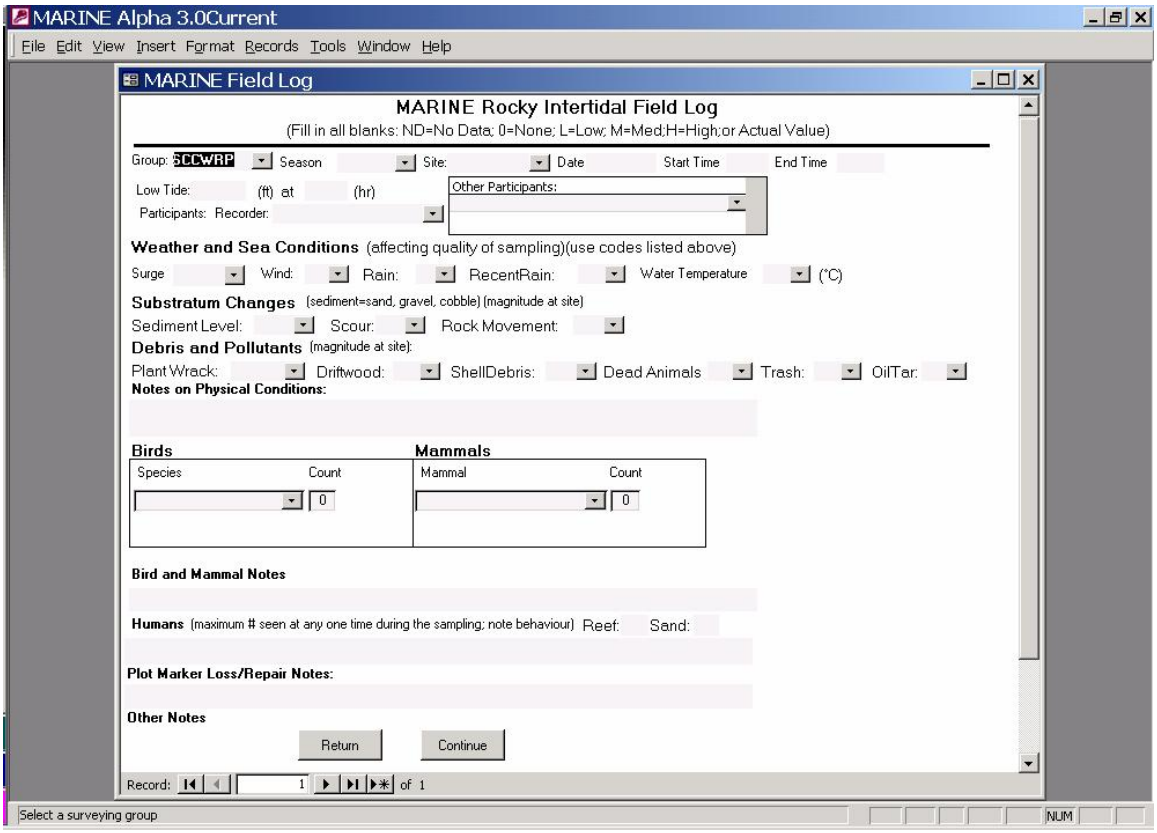

Figure 3. The Field Log Event data entry form from the MARINe database created by Southern California Coastal Water Research Project.

Recommendations for Routine Data Summaries and Statistical Analysis to Detect Change

Data summaries may help to synthesize noteworthy events and interpret data in that context as well as summarize data for later trend analysis. Specific summary charts and queries are available within the MARINe database and may be utilized as necessary (SOP #14: Data Entry and Management including uploading to MARINe Database). To examine variation in the abundance of target species in space and time, summary statistics (mean and standard error of the mean) for all sites and sample periods are calculated and graphically displayed (SOP #15: Data Analysis and Report Writing). These results will be reported in annual reports. Analyses of covariance (ANCOVA) procedures are used to assess seasonal and temporal patterns of abundance for each of the target species at each site (Miner et al. 2005).

All data collected by MARINe, including RNSP data, are available to scientists on request. These data are used in a variety of analyses and scientific publications by the broader scientific community. See the MARINe publication list for an extensive catalog of scientific literature using intertidal monitoring data collected by MARINe. In addition, RNSP data can also be obtained from the Data Manager at the Klamath Network.

Recommended Reporting Schedule

Regular reporting for the RNSP sites will occur annually and will be the responsibility of the Lead Project Field Biologist. Annual report outputs will be created from the database (SOP #15: Data Analysis and Report Writing). Once data from the spring and fall sampling events have been entered and summarized, they are to be presented in an annual report format. The format is standard, published as a Technical Report for RNSP. Annual reports are generated for each calendar year or, infrequently, may span several years when report output has been delayed. Annual reports will be delivered to the Klamath Network for internal review by October 1. In addition to annual reports, every five years a trend analysis report will be created by the Lead Project Field Biologist and Principal Investigator.

Recommended Report Format

Annual reports and 5 year reports summarizing the data collected within RNSP will be presented in the NPS NRTR format. Details for report writing are in SOP #15: Data Analysis and Report Writing.

In general, the report will follow the outline below:

Title Page, with Technical Report number
Abstract
Table of Contents
List of Tables
List of Figures
Executive Summary
Introduction
Results
Discussion
Acknowledgements
Literature Cited
Appendices

Recommended Methods for Long-term Trend Analysis

After five years of data have been collected, a comprehensive report will examine long-term trends. This time span will allow for adequate data collection for a comprehensive usable report. Focused analysis of the data to detect change, to report trends, and to report statistical significance will be presented in the trend analysis report. The reports may be in conjunction with other northern California and Oregon sites to encompass a broader scale and be able to make comparisons with sites outside of RNSP. These reports will be similar to the recent report released covering 10 years of data from southern and central California intertidal monitoring (Miner et al 2005).

Data Archival Procedures

All data will be archived in the established MARINe database with backups of data and digital photos on the University of California at Santa Cruz computer server, as well as CD or DVD backups of photos and data. Archived versions of the database will be stored by the Klamath Network's Data Manager, who is responsible for making sure they are stored in their proper location, properly backed up, and correctly named. All data and information will follow guidelines provided in the Klamath Network's Data Management Plan.

Personnel Requirements and Training

Roles and Responsibilities

This protocol will be implemented through a California Cooperative Ecosystem Studies Unit (CESU) agreement between the University of California at Santa Cruz (UCSC) and the National Park Service, Klamath Network. UCSC will provide staff, equipment, and materials to perform the work of this task agreement. Dr. Pete Raimondi of UCSC will be the Principal Investigator. The Principal Investigator is responsible for coordinating the implementation of this protocol with a Lead Project Field Biologist. The designated Lead Project Field Biologist is specifically responsible for timely collection and dissemination of information, reports, and findings pertaining to the responsible management of the Rocky Intertidal resources at RNSP. Trained biological researchers/technicians are responsible for assisting the Lead Project Field Biologist with preparations for field work, monitoring, and help with volunteer supervision. A field crew of four to six trained researchers will conduct the monitoring at RNSP. They will be responsible for sampling logistics, packing and maintaining gear, field sampling, and data entry. An Agreement Technical Representative (ATR) will help coordinate efforts between the University and National Park Service. Redwood National and State Parks field biologists, technicians, and volunteers will aid in field sampling in order to maintain the park's involvement in this project. Trained specialists will deal with photo analysis, as well as data analysis and report writing. The Klamath Network Data Manager will assist with data archiving, data security, data dissemination, and metadata procedures; will post information in the National I&M databases; and will manage the information on the web sites, as well as manage all data submitted.

Qualifications

In order to collect long-term standardized data that can be compared along an extensive spatial scale, the level of expertise among samplers is critical. Taxonomic experts in marine algae and invertebrates are necessary to ensure the reliability of data. Field researchers must be physically fit and able to carry 50 lb backpacks across uneven terrain, including on steep ascents and descents, in various weather conditions. Photo analysis will be conducted by a highly trained and experienced expert that analyzes all digital photoplots for the northern California intertidal monitoring groups.

Training Procedures

SOP # 2: Training Field Workers outlines training procedures for new workers and continuous updates for all researchers. Training begins with a general academic background in marine sciences that is enhanced through supervised field experience. All groups involved in the marine intertidal sampling network collaborate on training procedures and gather on an annual basis to review protocols and taxonomic issues. These meetings allow the various groups to review taxonomic changes and maintain a consistent sampling regimen. The cost of attending annual

meetings is covered by the larger sampling networks. The benefits are that no additional cost will be reflected in the RNSP budget for these meetings.

Operational Requirements

Annual Workload and Field Schedule

This protocol is designed as a CESU agreement between the NPS and the University of California at Santa Cruz (UCSC). By contracting UCSC for the intertidal monitoring at RNSP, the Klamath Network is participating in an existing network of intertidal research. Researchers and field technicians for this project are employees of UCSC. In cooperation with RNSP, the UCSC researchers will coordinate and lead sampling events. Sampling will occur twice annually at each site during a low tide series. A summer sampling event will occur between May and June and a fall/winter sampling event will be attempted between November and January. Ocean conditions during the winter months may occasionally prevent sampling. Each site requires two days of sampling, employing a field team of four to six researchers. One or two members of the field crew may be RNSP employees, if available. Each sampling trip involves several days of pre and post-trip planning and packing. Post-field data processing will be conducted at UCSC facilities by UCSC specialists. Photo analysis requires one day per site per sampling event (six days annually) and data entry requires approximately one day per sight per sampling event (six days annually). Data analysis and report writing will require several weeks annually.

Once the data and information is transferred to the Klamath Network from UCSC, the data management steps that the Klamath Network Data Manager is responsible for include: adding any documents to NatureBib; updating metadata in the Data Store; updating species lists in NPSpecies; updating web sites with the latest reports; organizing and storing the information on the network server; adding reports and images to their corresponding databases; distributing reports to park staff, interested scientists, and SOU; and creating Resource Briefs.

Facility and Equipment Needs

Facilities at the University of California's Long Marine Laboratory (LML), Santa Cruz, CA, will be used for storing gear, processing samples, and performing photographic analysis. Specialized equipment, such as the PVC photo framer, are built and maintained at LML (SOP #5: Photographing Plots and Taking Area Photos). For a field equipment list, refer to Table 2. Automobiles for travel to field sites are maintained and provided by LML.

Table 2. List of field supplies needed for various intertidal sampling methods.

Field Lists

All
- ❑ Clipboards with rubber bands
- ❑ Pencils
- ❑ Waterproof datasheets
- ❑ Site Map
- ❑ Compass
- ❑ Kneepads
- ❑ Reference books
- ❑ "Community Structure Field Notebook" with site photos
- ❑ Foul weather gear/boots

Installation/Repair
- ❑ Cordless Drill + 2 spare batteries
- ❑ $^{3}/_{8}$ in bits and $^{5}/_{8}$ in bit (at least 2)
- ❑ Hammer
- ❑ Z-spar 2 part epoxy
- ❑ Water bottle
- ❑ Notched Stainless Steel bolts (various sizes)
- ❑ Unnotched Stainless Steel bolts

Community Structure Sampling

Photographs
- ❑ Digital Camera (5.0+ mega pixel)
- ❑ Underwater camera housing
- ❑ Camera mount
- ❑ 5-10 Quadrats
- ❑ Strobe with cable
- ❑ 4 AA batteries (plus 4 spares)
- ❑ Dry erase marker
- ❑ Camera manual
- ❑ Strobe manual
- ❑ Screw driver

Sea Stars
- ❑ Meter tapes (many)
- ❑ Rulers
- ❑ Yellow forestry crayon
- ❑ Flashlights

Surfgrass
- ❑ Meter tapes

Mobile Invertebrate Counts
- ❑ Quadrats
- ❑ Calipers
- ❑ Small containers

Barnacles
- ❑ Nut driver
- ❑ Labeled replacement plates
- ❑ Barnacle rack
- ❑ Field microscope
- ❑ Steel brush

Overview Photos
- ❑ Quadrats
- ❑ Digital Camera

Startup Costs and Budget Considerations

The sites at RNSP have already been established. The sampling at RNSP will be conducted by a group from UCSC that already maintains other sites. The database has also already been established and is fully functioning. The maintenance of the database is a shared cost between a network of monitoring groups. These factors eliminate startup costs and greatly reduce the cost of data management. The annual budget for maintaining sampling at the three sites on a biannual basis amounts to $25,000. This averages approximately $4,000 per site per sampling event. The following list shows a general breakdown of the budget for annual sampling of RNSP:

Salary:	$14,500
Benefits	$3,625
Supplies	$500
Travel	$2,000
17.5% Federal Overhead	$4,375
Total Annual Budget	$25,000

Salary can be broken down into the following categories:

Field Technicians:

Four trained researchers and one or two volunteers. Four to six (at least four paid) field researchers sampling two times annually at three sites with two days allotted for each site and four days total allotted for travel and prep and post field work yields approximately 56 worker days. Some additional assistance may come from volunteers or student interns. The main tasks of each position are broken down into percentages.

Field Crew (Training) ~ 10% = $1000
Field Crew (Preparation) ~ 10% = $1000
Field Crew (DataCollection) ~ 70% = $7000
Field Crew (Data Verification) ~ 10% = $1000
4 workers x 2 annual trips x 10 days each trip = 80 worker days or 640 hours ~($10,000)

Data Entry and Verification:

One trained technician. Each sampling site requires an average of two days of data entry and verification annually. The main tasks of each position are broken down into percentages.

Data Entry Technician (Verification, Validation, Scanning Datasheets, Organizing, and Filing Datasheets) = 25% = $250
Data Entry Technician (Data Entry) = 75% = $750
Data Specialist x 6 days= 48 hours ~($1,000)

Photo Analysis:

One specialist. Each site requires approximately one day of analysis per sampling event.

1 specialist x 3 sites x 2 trips annually x 1 day = 6 days or 48 hours ~($1,000)

Data Analysis and Report Write-up:

Two specialists (including Lead Project Field Biologist). General data analysis will occur annually, with more exhaustive analysis every five years. The trend reports published approximately every 5-10 years require months to complete.

Data Analysis (Routine Data Summaries, Analysis to Detect Trend, Data Validation) = 40% = $1000
Reports and Presentations (Annual and Analysis Reports, Scientific Papers, Presentations) = 60%= $1500
2 specialists x 10 days annually = 20 days or 160 hours = ~ ($2,500 annually)

Total Salary: $14,500

Additional Cost:

Network Data Manager. The cost of work done by the Klamath Network Data Manager is approximately $2150. This is not taken out of the projects budget but is in accordance with the agreement between the Klamath Network and UCSC.

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Standard Operating Procedures (SOPs)

SOP # 1: Pre-season Preparations

Version 1.00 (March 2008)

Revision History Log:

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This Standard Operating Procedure (SOP) covers general information for planning and scheduling sampling trips to intertidal field sites at Redwood National and State Parks RNSP). Pre-trip planning includes housing and transportation to sites as well as organizing sampling and personal gear. Biannual sampling of the three rocky intertidal sites requires a great deal of advance planning and coordination among various park staff and partners.

I. General Overall Scheduling Considerations

Field sampling at the RNSP sites requires about 10-15 days of field work per annum to complete regular monitoring protocols. Sampling is biannual, completed each fall/winter and spring/summer. The fall/winter sampling is generally completed between November and January, while spring/summer visits occur between May and June.

Prior to each sampling season, travel and housing needs should be drafted and requested. Planning for the season should begin three to six months before the sampling season**.** The key is to plan and book early.

Consideration of factors, including time of and the number of days in a low tide series, transportation availability and travel distance, number of monitoring sites, number of plots, and anticipated need for and availability of sampling assistance, will likely influence the order and dates of visitation during a sample season. As expected, specific knowledge of sites and familiarity with sampling nuisances is helpful for this type of field work planning.

Sampling requires a reasonably good tide series (4-5 days) of negative tides (-0.0 MLLW or lower) for access to and time for the completion of all protocols. Generally, one site per day can be sampled, owing to the distance between sites and to time and transportation constraints. With advance preparation and adequately experienced personnel, each monitoring site can be completely sampled in one visit. Although some sites might be workable with a +0.5 ft tide, generally these higher tide levels will not afford enough time to complete all protocols, especially when swell is present.

To predict the tide series, use software programs (e.g., Nautical Software, tides and currents for windows) or web-based applications (e.g., NOAA's Tides and Currents: http://tidesandcurrents.noaa.gov/tides06/). Features vary by application but will allow you to view predicted tidal levels for the nearest station (Crescent City) by month or by selected criteria (e.g., all low tides less than -0.1 and during certain hours) and will assist with your planning for near-future sampling trips. Sampling is limited to daylight tides for safety and common-sense reasons.

II. General Considerations for Transportation and Housing Scheduling

It will be the Lead Project Field Biologist's duty to arrange transportation and housing prior to each sampling trip. Transportation and housing basics are subject to change. It is possible that those changes are not adequately reflected by this protocol, due to unforeseeable future circumstances. A sampling trip will be subject to cancellation or modification if severe weather, transportation problems, seasonal closures due to sensitive or endangered species, or other unforeseen circumstances arise.

The following section provides general information for (1) vehicle and (2-3) housing considerations prior to trip departure:

1. A University vehicle must be reserved in advance of the trip. Vehicle requirements include space for four to six people and sampling gear. Driving from the University of California at Santa Cruz (UCSC) to the field sites at RNSP takes approximately 8 hours and requires an extra day on either end of the sampling trip.

2. Camping is available by reservation at Mill Creek Campground at RNSP, near the sampling sites. Mill Creek Campground is located 7 miles south of Crescent City, CA, on U.S. Highway 101. Camping is only available for the summer sampling trip, as campgrounds are only open from May 1 to September 30. Reservations can be made for a campsite by calling **1-800-444-7275**. Other camping options within RNSP include the Gold Bluffs Beach and Prairie Creek Campgrounds. Reservations should be made at least 30 days prior to visiting the site to ensure availability.

3. There are several hotel options in Crescent City for the fall/winter sampling. Book rooms well in advance (one to two months). Crescent City is approximately 30 minutes from the sampling sites.

The following section provides driving directions and a map to the three RNSP intertidal sites:

Take U.S. Highway101 North from Arcata to all sites (or South from Crescent City)

False Klamath Cove: the pull-out is about 4 miles past the Klamath River Bridge on the left (west) side of Highway 101, at Wilson Creek.

Damnation: the turn-off is 10.0 miles north of the Klamath River Bridge (marked by two golden bears), in Redwood National Park.
Turn left (from south) just past mile marker 15.40, onto the small dirt fire road with the closed gate and park.
Take the fire road (about ¾ of a mile) to the trail that leads down to Damnation Cove (do not take Damnation Creek Trail back up to the main road). There is a trail marker on the Coastal Trail down to Damnation that warns of a steep and strenuous trail.
The site is to the left (downcoast) of Damnation Creek (except second set of mussel plots, which are upcoast of Damnation Creek).

Enderts Beach: Turn west off of Highway 101, just south of Crescent City, on Enderts Road. Follow the road to the parking lot that ends at the trailhead. Hike down about ½ of a mile to the beach and then head south to the rocky section of beach at the end. Go through a large hole in the rock wall to the other side. This is where the site is located.

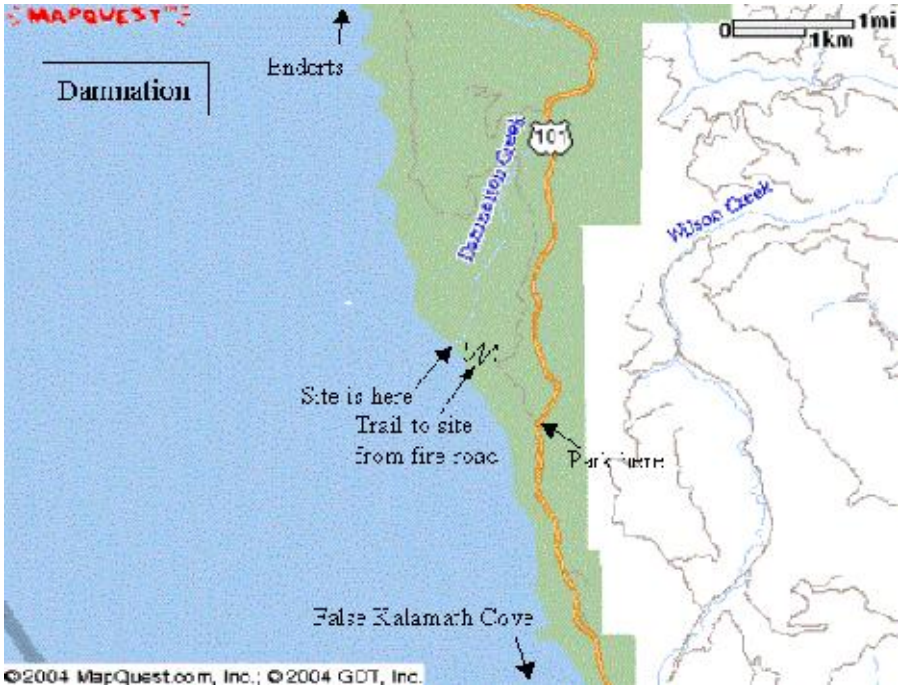

Figure 4. Picture of the Damnation Creek monitoring site.

III. Organizing Field Work Supplies and Equipment – A Checklist

Once transportation and housing are secure, the final factor in planning for a successful monitoring trip is to secure the necessary equipment, supplies, and personnel in advance. Supplies used for RNSP sampling trips are maintained and stored at the University of California's Long Marine Laboratory in Santa Cruz, CA. This will be the responsibility of the Lead Project Field Biologist. The field personnel are UCSC employees who are hired by the Principal Investigator of the project. Field volunteers are coordinated by the Lead Project Field Biologist.

In general, remote monitoring poses additional planning effort. You will need to bring extra gear, such as a back-up camera, extra sampling grids, and batteries, because the unexpected happens and resources are very limited in the area. While it may be possible to purchase some things at the local hardware store in Crescent City (e.g., batteries), for the most part sampling crews need to be "self-contained." It is always a good idea to contact park personnel prior to your departure to receive updates on any special changes in terms of area access. Information, including phone number links, is located at: http://www.redwood.national-park.com/visit.htm. The park phone number is **707-465-7306.**

Some tips are as follows: Remember to bring enough drinking water for your whole party. Weather changes often, but you can expect hot days and chilly nights; dress in layers. Both good hiking boots and intertidal sampling footwear are especially needed, as travel routes and monitoring sites are tough on the feet. Expect variable changes to conditions, especially weather and sea state conditions. Always check the daily weather forecast before you depart. Extreme caution should always be exercised, particularly at sites with high swell or in rough sea-state conditions.

Compile Checklist

1. An equipment list should be compiled, with equipment organized and made ready for the field several days in advance of the sampling event. Table 3 is a SAMPLE checklist for field equipment necessary for adequate sampling of rocky intertidal monitoring sites.

2. Remember to make **scheduled maintenance and periodic operational checks** to equipment between periods of use or disuse.

3. Before departing for the site, make sure **all field gear is in good working order** far enough in advance to repair or replace damaged or missing items. Inventory and purchase any consumable supplies needed, such as batteries, flash memory cards, etc. Recharge batteries for cameras, strobes, drills, radios, and other electrical items. While most camping facilities and hotels have power for recharging equipment, it is good to determine the availability of outlets prior to making reservations. Print enough datasheets to cover all the monitoring sites, plus some additional sheets. It is critical that you have all necessary site maps, site descriptions, GPS, and other equipment for all sites prior to departure. Prudent planners read previous trip notes to decide if special equipment or sampling will be required.

4. In addition to field equipment, each member of the monitoring group will need to bring his/her personal gear. A personal gear list is provided in Attachment A.

Table 3. Field equipment checklist for rocky intertidal sampling.

ROCKY INTERTIDAL SAMPLING GEAR CHECKLIST	
Suggested # for field	Description by Task Category
	Photoplot Monitoring and Site-Wide Data Collection
1	Photoquadrat camera frame ("quadrapod"), with four legs and camera mount
1	PVC 1 m^2 quadrat, with dividing strings and two metal rods and binding straps
1	Olympus C-5050 camera with underwater housing, rechargeable batteries, and spare batteries
1	Light diffuser
1	Tally clicker bank
2	Duct tape and Sharpie marker (for photoplot reference marking)
5	"Rite in the Rain" photoquadrat datasheets and species log for censuses
1	Flagging tape
	Species Counts and Size Frequencies
10	PVC 1-m^2 quadrat WITHOUT dividing strings (for motile invertebrate counts)
5	Yellow marking pencils
5	Stainless steel calipers for measuring
5	Long forceps
5	Size Frequency datasheets
5	10 x 10 cm quadrat (for sub-sampling motiles)
5	20 x 20 cm quadrat (for sub-sampling motiles)
	Plot Repairs and Installation
2	Rock hammer
1	Splash zone epoxy, in two separate tubs
10	Spare stainless steel lag bolts
2	Wire brush
1	Drill with masonery drill bit
2	Paint scraper
1	Metal detector
	Miscellaneous, Emergency, and Personal Equipment
1	Field notebook with site maps, photos, etc.
2	Compass for direction between plots and to find subplot azimuths and aspects
5	Clip boards for recording data and carrying datasheet
4	Backpacks for carrying equipment
several	Reference books for species identifications
several	Insect repellent
several	Sunscreen
1	First aid kit
	Personal prescribed medications

Attachment A. Personal Gear List

Daypack
Tidepool sampling gear, including shoes that can get wet and that have good traction!
Toiletry kit and any other personal items (including medication, etc.)
Towel(s) (a small towel to dry your feet before changing back to boots is a good idea)
Sleeping bag and tent (if camping is planned)
Pillow case (minimally) or your own pillow and a top sheet if you want
Sturdy hiking shoes or boots
Spare "camp" shoes (for the night, should boots stay wet)
Warm, layerable clothes (including gloves)
Warm hat
Sun hat or ball cap
Flashlight
Sunglasses
Water bottle/canteen
Sunscreen
Raingear (check the forecast!)
Foul weather gear

SOP # 2: Training Field Workers

Version 1.00 (March 2008)

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This Standard Operating Procedure (SOP) summarizes expectations for and the training of field workers and volunteers participating in the Rocky Intertidal Monitoring Program at Redwood National and State Parks (RNSP).

I. Expectations for Field Researchers and Workers

Rocky intertidal monitoring at RNSP requires a crew of at least four experienced researchers and at least two others who may be less experienced or volunteer workers. Experienced researchers have undergone extensive field training, have taxonomic expertise in identifying rocky intertidal organisms, and have participated in numerous field sampling trips. They are the primary data collectors for meeting the Program's objectives.

To ensure reliable collection of field data, site-specific training is necessary and expected of workers, particularly those classified as "less experienced." Less experienced workers include volunteers and field assistants with little prior background in sampling methods or field identification of organisms and recent hires who have not participated in prior RNSP monitoring programs. Less experienced individuals will be required to participate in several sampling trips and to learn RNSP protocols prior to collecting data themselves.

Although new or less experienced workers may not collect data themselves, many important supporting tasks can be assigned. New or inexperienced workers can be taught (with minimal instruction) on how to record data for an observer, while gaining experience in field sampling methods. A field supervisor may increase the responsibilities of new workers when he or she deems them competent and proficient and an appropriate training period has passed. The training period is not set and can vary considerably depending upon the individual. Once a new worker has demonstrated his or her ability to perform sampling with a high degree of accuracy and precision, then he or she can begin independently collecting data. However, this worker's initial sampling efforts should be double-checked by experienced workers and periodic rechecking of data collection is appropriate for all levels of experienced workers.

Effective field monitoring requires pre-planning and good communication among all participants. Because all sampling (SOP #3-11) is somewhat restricted by the tidal cycle and some tasks are further restricted to specific low tidal heights, the order with which the tasks are

completed will require flexibility and communication among samplers. It may be required that one task be set aside to complete another.

A "Field Plan" which outlines who is going to complete which monitoring task and in what order will be discussed prior to each sampling effort. Sampling duties can be divided among the six workers into the following tasks:

1. Site/Gear set-up (2-3 workers familiar with site).
2. Overview photos (1 experienced photographer).
3. Seastar plots (1-2 experienced sampler(s) with 1 data recorder).
4. Mobile invertebrates (2-4 experienced samplers with 1 data recorder each).
5. Surfgrass transects (1 experienced sampler with 1 data recorder).
6. Photographing plots (1 experienced sampler).
7. Plot sketches (1 experienced sampler).
8. Temperature logger swap (1 worker familiar with this task).
9. Plot repairs (1 worker familiar with this task and comfortable using the hammer drill).
10. Field log (completed at the end of the day with participation of all workers).

II. Training New Workers

Most training occurs in the field. However, familiarization with protocols, datasheets, and species identification using guidebooks and web-based information (Attachment B) can and should occur prior to field trips. Inexperienced or volunteer workers should be additionally instructed as to any necessary supplemental procedures in order to increase overall sampling effectiveness and efficiency.

Pre-field training instruction will:

1. Provide an overview of sampling procedures.
2. Provide copies of datasheets and instructions on how to complete the datasheets.
3. Identify target, core, or optional species with resources to find pictures and species descriptions (Attachment B, Appendix E).
4. Outline necessary gear and protocols for safety and minimizing hazards.
5. Familiarize participants with sites and maps and locating photoplots and reference bolts.

Additional training including specialized taxonomic training or mock data collection exercises are encouraged.

III.Ongoing Training

The intertidal monitoring protocols are subject to modification. Additionally, species ranges may change, creating the necessity to alter existing species lists. Therefore, all groups involved with intertidal monitoring should maintain contact and regularly meet to discuss changes and taxonomic questions. There are currently annual taxonomic meetings of members of the MARINe monitoring group. See http://www.marine.gov/ for current meeting schedules and other

updates. At least two people involved in the intertidal monitoring for RNSP should plan to attend this annual meeting.

Attachment B. Field Guides and Resources for Identifying Intertidal Algae and Invertebrate Species

Abbott, I. A., and G. J. Hollenberg. 1976. Marine algae of California. Stanford University Press Stanford, California.

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Murray, S., and E. Yee. 2004. Intertidal species. World-wide electronic publication. California State University, Fullerton. Online. (http://www.marine.gov/species.htm). Accessed 27 February 2008.

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SOP # 3: Establishing and Maintaining Plots

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This Standard Operating Procedure (SOP) provides information regarding establishing new intertidal monitoring plots or transects and maintaining plots. The Rocky Intertidal Monitoring Program at Redwood National and State Parks (RNSP) is designed using a fixed-plot approach, meaning that repeated measurements are taken from the same locations through time. Fixed plots are permanent areas of rocky intertidal habitat defined by epoxy or bolt markers. Fixed plots may be variable in size and shape, including rectangular, irregular, or one-dimensional transect lines. Specific plot types are discussed in separate SOPs for individual sampling methods.

I. General Survey Considerations for Establishing New Photoplots

Permanent plots or transects are generally established during initial site set-up but may be added to expand the surveys at an existing site. Each plot chosen for monitoring should have a high percentage (70% or more) of the target species and needs to be relatively flat, though not necessarily horizontal. Photos will be best if the entire plot falls into a narrow field of focus with no heavy shadows from rock cracks or boulders. Reflections on pools may obscure what is below. The frame should be able to rest on the plot. Five plots that are representative of each zone are established. A stratified random approach can be used by identifying all the possible plot candidates within a target zone, numbering them, and randomly selecting the five to be established. Using numerous quadrat frames (50 cm x 75 cm) laid out as guides helps to locate overall layout.

Procedure for Establishing New Plots

1. Locate plot position following general considerations above.

2. An area of about 5 cm x 5 cm is cleared to bare rock below each quadrat corner using scrapers and wire brushes as needed.

3. A hammer drill is used to drill $^{5}/_{8}$ inch holes, approximately two inches deep, in the rock substrate below the three corners of the quadrat.

4. Plots are marked with stainless steel bolts in three corners: the upper left, upper right, and lower left corners. For plots that may be overgrown by mussels, it is recommended that

longer stainless steel (SS) hex bolts (3/8" in diameter and 4-6" long) be used in at least two corners to mark the plot. The upper left bolt is marked with one to five notches in the head to identify the plot number for each zone (1 = plot 1, 5 = plot 5). A dollop of marine epoxy (combined to activate in field using a little seawater) is pressed into the drilled rock at each corner to secure the bolt. Clean rock is important for good adhesion of the epoxy.

5. The upper left corner of the plot is numbered. The standard convention for choosing the upper left has been when viewing the plot with one's back to the ocean. Some plots cannot be photographed from that orientation, however, and then the upper left corner should be chosen according to how the photo will be taken. Refer to SOP #5 for more details about taking plot photographs.

6. For new plots, pre-establish what the plot numbers will be. Remember unique numbers from all other plots at the location must be used. Number changes need to be avoided for data consistency.

7. Careful mapping is necessary to be able to distinguish plots *between* adjacent zones, as each zone has bolts marked 1 through 5. See number 4 below for more detail.

Procedure for Maintaining Plots

1. Finding corners overgrown by organisms is occasionally a problem, especially in the mussel zone. Clean the corners with a scraper or wire brush on each visit to clear the growth (so that corners can be located more readily next visit).

2. If necessary where bolts are overgrown by mussels, install longer SS hex bolts ($^3/_8$ inch in diameter and 4-6 inches long) in at least two corners to mark the plot.

3. Metal detectors can be used to find hidden bolts (i.e., when covered by more than 6 cm of growth, like mussels).

4. Map and photograph new plots and place documents in the program data binder. Detailed descriptions, maps, and area photographs (with quadrat frames left in place as visual reference) are important. Differential GPS units are used to create relatively accurate and precise maps of individual plot locations and site features. However, even with the best precision, finding individual plots with a GPS is not yet practical. Therefore, descriptive mapping of topographic features such as pools, ridges, and cracks in the rock are still more valuable in finding the individual plots. Interplot measurements (distances and compass bearings) between plots are important in relocating lost plots (Attachment C). Overview photos of the site, from different angles and with the individual plots identified, can also be very useful.

Attachment C. Interplot Measurement Datasheet.

INTERPLOT MEASUREMENTS

site:______________________________ date:__________________

From	To	Distance	Bearing	From	To	Distance	Bearing

SOP # 4: Completing Field Logs and Assessing Site-wide Species Conditions

Version 1.00 (February 2008)

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The Rocky Intertidal Monitoring Program at Redwood National and State Parks (RNSP) is designed to identify and follow trends in population dynamics of selected indicator organisms within the rocky intertidal zone. The program is conducted biannually, with visits each fall and spring to three fixed monitoring sites. Field logs are required at each site even if visited off-season (e.g., plot maintenance or research-oriented visits). Field logs are the basic means of recording what becomes the metadata for each site visit (i.e., who, what, where, when). They are also the means for recording any observations about an area, species, or event and will become the basis for future trip reports. This Standard Operating Procedure (SOP) details the mechanics of completing accurate field logs and assessing site-wide conditions for all monitoring efforts. An explanation of field form and data codes is presented in Attachment D. The Field Log and Site-wide Species Condition Datasheet is provided in Attachment E.

I. General Considerations

General site notes are an integral part of monitoring work; researchers working at sites from San Diego to the Oregon/Washington border have an identical list of core species for which relative abundance (including absence) and condition (e.g., reproductive, bleached) is recorded. This standard species list allows monitoring groups to consistently make general observations about species that are not targeted in specific plots. Field observations are important in light of recent evidence suggesting that species ranges may be shifting due to global warming (Barry et al. 1995.) and also that introductions of non-native species into the marine environment are rapidly increasing (Carlton and Geller 1993).

During each site visit, it is important to complete a field log (i.e., who, what, where, when) as well as to observe and record general physical and biological conditions at the site. The Lead Project Field Biologist is responsible for filling out the field log, but input from all members of the field crew is important. Physical and weather-related conditions are collected initially upon reaching the site, as are counts of birds, marine mammals, and humans. Other impressions and observations are collected throughout the monitoring event by all field crew members. The field log will provide a narrative of the sampling effort and may aid in the interpretation of data from fixed plots, area photos, and transects.

Additional site-wide categorization of target and other core species abundance, appearance, and recruitment is collected whenever time permits. Site-wide data (back page of the Field Log datasheet) are collected to provide categorical estimates of site-specific abundance, condition, and recruitment level of certain target/core/optional species and are usually scored upon completing other monitoring protocols.

The goal of a well written field log is to provide an accurate and succinct record of general observations at the monitoring site, weather conditions, participants, changes to or deviations from the protocols, and unique or unusual occurrences. Equipment required includes: MARINE Field Log datasheet (includes "Rocky Intertidal Monitoring Site-wide Species Conditions" on the reverse side), clipboard, and submersible thermometer.

A field notebook should also be maintained that includes site maps, interplot measurements, GPS measurements, tidal heights, text descriptions, and multiple photographs for each plot. The field notebook for each site will be consulted prior to sampling and will be brought on sampling trips. This guide should help samplers with site and plot orientation and should be consulted often to avoid changes in plot orientation through time. It should be kept up to date with changes and additions. It will be the responsibility of the Lead Project Field Biologist to maintain the field notebook.

II. Procedures

Procedure for Completing Field Log

1. Use the front page of the Field Log datasheet to record daily notes, observations, and site conditions. Field Log / Site-wide Species Conditions datasheet should be printed on Xerox Never-Tear Paper for inclement weather conditions or on multipurpose 20 lb-weight Xerox paper if conditions are expected to remain dry. Field logs can be filled in with pencil. Clearly cross out errors or extraneous marks; do not erase. Be as complete as possible and write in complete sentences.

2. Site, Date, Time, Low Tide, and Participants should all be filled in upon arrival to site.

3. Weather and sea-state conditions, estimates of substratum changes, and debris and pollutant accumulations are noted (Attachment D). Should conditions change in the course of sampling (e.g., fog descends or swell increases), document those changes (especially if it affects the quality of the monitoring sampling) in "Notes on Physical Conditions." Remember the main reason for noting weather conditions is how it relates to sampling effort and how it may affect the organisms (e.g., shorebirds) seen.

4. Birds and mammals will require a certain level of species familiarity and careful observation periodically during sampling. Generally, maximum numbers of bird and mammal species are observed when you first approach the site, so begin counts as you approach.

5. Document human activity observed while at the monitoring location (other than the monitoring party).

6. Note plot marker losses and repairs made.

7. Record other notes as needed.

8. Complete the "Survey Checklist" at the bottom of the page after completion of the day's sampling.

Procedure for Assessing Site-wide Conditions

1. Use the reverse side of the Field Log datasheet to record daily notes, observations, and site conditions. Field Log / Site-wide Species Conditions should be printed on Xerox Never-Tear Paper for inclement weather conditions or on multipurpose 20 lb-weight Xerox paper if conditions are expected to remain dry. Site-wide Conditions can be filled in with pencil. Clearly cross out errors or extraneous marks; do not erase. Be as complete as possible and write in complete sentences.

2. Give highest priority to scoring Target Species, particularly those monitored at the site. Core species should be scored when possible, or indicate "no data (ND)."

3. When scoring, consider the site-wide condition of the species within its annotated zone(s) of occurrence.

4. These assessments will go into the MARINe database, along with other notes from the Field Log, so use the standard categories provided in each column and **base decisions on the abundance or condition of that organism site-wide within the range of its habitat**.

5. Other species can be added if desired; however, they will not be entered into the MARINe database unless they have been designated as an optional species. It is not practical to score for non-discrete algae and most small invertebrates where determination would be too time-consuming.

Procedure for Datasheet Management

1. At the end of the field day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are completely filled in. Add any other notes as appropriate.

2. File the Field Log datasheet with other datasheets from the monitoring event in the data binder, to be entered into the MARINe database.

3. At the end of the field season, copies of the field logs will be delivered to the Network Data Manager at the Klamath Network office, where they will be scanned into one PDF document. The electronic file will be stored in the Intertidal project folder (Mohren 2007). The hardcopy copies of the field logs will be stored in a locked file cabinet.

II. Literature Cited

Barry, J.P., C.H. Baxter, R.D. Sagarin and S.E. Gilman. 1995. Climate-related, long-term faunal change in a California rocky intertidal community. Science **267**:672-675.

Carlton, J. T., and J. B. Geller. 1993. Ecological roulette: The global transport of nonindigenous marine organisms. Science **261**:78-82.

Mohren, S. R. 2007. Data Management Plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR—2007/012. National Park Service, Fort Collins, Colorado.

Attachment D. Explanation of Field Form and Data Codes for Attachment B (MARINE Rocky Intertidal Field Log / Site-wide Conditions Datasheet)

Front Side: "MARINE Rocky Intertidal Field Log"

Site: Designate clearly with Site Code.

Date: Clearly record in standard American date format (month/date/year).

Time: Expressed as military time (24-hr clock) (e.g., 0800 to 1630) and should reflect **time onsite (**i.e., excludes hiking/travel time).

Low tide: State negative datum (in feet) at time (hr) based on predicted tide chart.

Participants: List all participants, your name given first as recorder. Use full last names.

Weather and Sea Conditions, Substratum Changes, Debris and Pollutants, and Notes on Physical Conditions: There are six generalized categories for describing physical and weather-related observations:

ND = No Data
0 = None
L = Low
M = Medium
H = High
[Value] = Actual value (e.g., 13 ^{o}C) as measured water temperature

Spaces are provided to record values or categorical levels (**0, L, M, H**). Record accumulations of tar, plant wrack (e.g., driftwood, natural organics), or debris (e.g., plastics). Note if tar is fresh or weathered. Explanatory notes or comments can be recorded in the "Notes on Physical Conditions" section. Describe the environmental working conditions, especially if these affect the quality of the monitoring sampling.

Birds and Mammals: Record the maximum number of shorebirds and marine mammals seen at any one time during the sampling. This will often be when you arrive on site, so approach slowly while observing through binoculars and counting. Identify to species when possible. Transcribe the number directly to the datasheet in the appropriate grid box to ensure accuracy. Also note any observed seabird or marine mammal stranding or any circumstances out of the typical in "Bird/Mammal Notes."

Humans: Record the maximum number of humans observed during sampling, including behaviors as appropriate. Allocate human visitors to one of two categories: "Reef" or "Sand," differentiating whether they are sunbathers on nearby beaches or rocky intertidal/snorkeler explorers at the reef site. Kayakers and recreational boaters should be separately described.

Plot Marker Loss/Repair Notes: Note any problems with lost markers or difficult to find plots and record any repairs completed or newly installed bolts or plots/transects. Identify problems that need to be fixed on the next visit. It is good practice to check past field logs prior to visiting a site for notes on needed repairs.

Other Notes: Useful things to note include: general appearance of algae and encrusting animals, damaged patches of reef, signs of disease, changes observed since the last visit, absence of animals or algae that might occur at the site, whether anything was done different from the standard methods, and problems encountered with equipment or locating plots.

Survey Checklist: Use the checklist to note completion of the different protocols with a check. It is helpful to indicate the number of plots completed and/or observer initials.

Reverse Side: "Rocky Intertidal Monitoring Site-wide Species Conditions"

Reading right to left, there are five columns of importance in completing this datasheet:

Species (Column 1) – Genus and specific name are given and **bold** identifies the organism as a target species. All effort should be made to evaluate target species site-wide and other species as time permits. Next to the species name is a one letter code (**H, M, L**), representing approximate tidal elevation this species is likely found; it is in reference to the zero datum, or mean lower low water (MLLW) level.

H = High Intertidal
M = Middle Intertidal
L = Low Intertidal

Abundance (Column 2) – There are seven categorical values for abundance.

ND = no data
0 = absent
R = rare
U = uncommon
P = present
C = common
A = abundant

Condition (Column 3) – This is a subjective evaluation of the overall appearance of the majority of individuals within its habitat/zone.

ND = No data
OK = healthy, not damaged
Unhealthy or Damaged condition:
UL = low level of damage/unhealthiness
UM = medium level of damage/unhealthiness
UH = high level of damage/unhealthiness

Recruitment (Column 4) – This is a subjective estimate of the level of new propagules or individuals "recruited" to the population.

0 = absent
ND = no data
L = low level of recruitment
M = medium level of recruitment
H = high level of recruitment

Notes (Column 5) – Space is provided for notes as needed.

MARINE Rocky Intertidal Field Log Definitions

Codes

No Data (----): Draw a horizontal line through any blank area to indicate that this category was not evaluated or does not apply.
None (0): None were found within the defined site boundaries.
Low (L): Relatively few or low levels were found within the defined site boundaries.
Med (M): Medium numbers or moderate levels were found within the defined site boundaries.
High (H): High numbers or high levels were found within the defined site boundaries.

Weather and Sea Conditions (emphasis on those affecting quality of sampling)

Swell/Surge: L/M/H relative levels of water movement over seaward portion of site.
Wind: L = ≤10 knots M = 11-20 knots H => 20 knots
Rain: L/M/H relative amounts of precipitation at the site during the survey.
Recent Rain: Evidence or knowledge of L/M/H amounts of rain at the site within the past few days.
Water Temp: Actual seawater temperature (°C) or L = ≤14°C (57°F), M = 15-18°C, H = >18°C (64°F).

Substratum Changes

Sediment Level: L/M/H relative levels of unconsolidated sand/gravel/cobble along reef/sediment interfaces.
Scour: L/M/H relative extent of scoured reef surfaces within the defined site boundaries.
Rock Movement: L/M/H relative extent of overturned boulders or bedrock breakouts.

Debris and Pollutants

Plant Wrack: L/M/H levels of unattached algae or other drift plants within the site.
Driftwood: L/M/H levels of sticks, branches, and logs within the site.
Shells: L/M/H levels of dead shells, especially mussel shells.
Dead Animals: L/M/H levels of dead invertebrates, fish, birds, or mammals.
Trash: L/M/H levels of human debris including cans, bottles, plastics, and metal items.
Oil/Tar: L/M/H relative extent of fresh or weathered oil/tar within the site.

Birds and Mammals

Core categories are listed and must be scored. Record maximum number seen at any one time during the sampling, preferably upon arrival at site. Other more specific categories or species may be added but must define linkage to core taxa. Only score species within the defined site, either onshore or within 50 m of shore. Note relevant behaviors.

Humans

Record maximum number of people seen at any one time during the sampling. Especially check at low tide. Separate counts for people on rock and on sand. Note relevant behaviors. Note also if people are present upcoast or downcoast of the site.

Plot Marker Loss/Repair, Other Notes, and Survey Checklist

These are optional categories. Information may or may not be added to the database as text entries.

Site-wide Species Conditions (especially Abundance, Appearance, and Recruitment)

Give highest priority to scoring target species. Core species should be scored or indicate no data. Other species can be scored if desired. Consider the site-wide condition of the species within its optimum zone(s).

Abundance: Relative numbers of individuals or cover of species, in five levels: **0**=Absent, **R**=Rare, **U**=Uncommon, **P**=Present, **C**=Common, **A**=Abundant with "Present" representing the middle level. Consider only the optimum zone(s) for each species throughout the site.
Appearance: Checkmark indicates typical "healthy" non-reproductive appearance. If appearance is not typical, pair noted appearance codes with level codes (FL, FM, FH, BL, BM, BH, DL, DM, DH). Score L/M/H relative levels of reproductive appearance (F) (plants showing evidence of fertility), bleaching (B) (plants only: e.g., appearing pale or translucent or red algae appearing greenish), or damage (D)(plants and animals: e.g., abraded, torn, broken, withered, diseased, injured, or dead individuals).
Recruitment: For appropriate species when evident, score L/M/H relative levels of recruit abundances (settlers that have become obvious since the previous sampling). This category is not practical for turf or other non-discrete algae and some invertebrates where determination would be too time-consuming.

Attachment E. MARINE Rocky Intertidal Field Log Datasheet (Front and Back)

MARINE Rocky Intertidal Field Log

(Fill in all blanks.: **----**=No Data; **0**=None: **L**=Low; **M**=Med; **H**=High; or Actual Value)

Site:_____ Date:_____ Time:_____ to _____ Low Tide:_____(ft) at _____(hr)
Participants (Recorder 1st):_____
_____
Weather and Sea Conditions (affecting quality of sampling)(use codes listed above)
Swell/Surge:_____ Wind:_____ Rain:_____ Recent Rain:_____ Water Temp (°C):_____
Substratum Changes (sediment=sand, gravel, cobble) (magnitude at site)
Sediment Level:_____ Scour:_____ Rock Movement:_____
Debris and Pollutants (magnitude at site):
Plant Wrack:_____ Driftwood:_____ Shells:_____ Dead Animals:_____ Trash:_____ Oil/Tar:_____
Notes on Physical Conditions:_____
_____
_____
_____
_____
_____

Birds and Mammals (maximum # seen at any one time during the sampling)(see bird/mammal list for other species)

Pelican	Great Egret			CA Sea Lion
Cormorant	Snowy Egret			Harbor Seal
Gull	Lg Shorebird			Elephant Seal
Tern	Sm Shorebird			Sea Otter
Oystercatcher	Other Birds			Dog
Blue Heron				

Bird/Mammal Notes:_____
_____
Humans (maximum # seen at any one time during the sampling; note behavior) Reef:_____
Sand:_____
_____
Plot Marker Loss/Repair Notes:_____
_____
_____
Other Notes:_____
_____
_____
_____
_____
_____
_____

Survey Checklist

Photoplots:___ Plot Sketches___ Field Scoring___ **Point-Transects**:___ Photos___
Owl Limpets:___ Photos___ **Abalone**:___ Time-Search___ **Seastars**:___ Time-Search___
Mobile Inverts:___ **Birds**:___ **Mammals**:___ **Humans**:___
Site Overview: Photos____ Video___ Field Log:___ **Plot Marker Repairs**:___

Rocky Intertidal Monitoring Site-wide Species Conditions

Species	Abundance	Appearance		Recruitment	Notes
Target Species shown in bold. **Optimum Intertidal Zone** (may occur in 1, 2 or 3 zones) **H=**High **M=**Mid **L=**Low	-----=No Data **0**=Absent **R**=Rare **U**=Uncommon **P**=Present **C**=Common **A**=Abundant	-----=No Data √=Typical (healthy) **F**=Fertile/Flowers **B**=Bleached **D**=Damaged	**L**=Low level **M**=Med level **H**=High level	-----=No Data **0**=Absent **L**=Low level **M**=Med level **H**=High level	
Cladophora columbiana ***ML***					
Ulva/Enteromorpha ***HML***					
Egregia menziezii ***L***					
Eisenia arborea ***L***					
Endarachne/Petalonia ***HM***					
Fucus gardneri ***HM***					
Halidrys dioica/Cystoseira spp. ***L***					
Hedophyllum sessile ***ML***					
Hesperophycus californicus ***H***					
Pelvetiopsis limitata ***H***					
Postelsia palmaeformis ***HM***					
Sargassum muticum ***L***					
Scytosiphon spp. ***HM***					
Silvetia compressa **M**					
Ahnfeltiopsis linearis ***L***					
Endocladia muricata **HM**					
Chondracanthus canaliculatus ***M***					
Caulacanthus ustulatus					
Mastocarpus papillatus ***HM***					
Mazzaella affinis ***M***					
Mazzaella spp.(= Iridaea spp.) ***ML***					
Neorhodomella larix ***ML***					
Porphyra sp. ***HM***					
Phyllospadix scouleri/torreyi ***L***					
Anthopleura elegantissima/sola ***ML***					
Phragmatopoma californica ***ML***					
Mytilus californianus ***ML***					
Septifer bifurcata ***M***					
Acanthina spp. ***M***					
Littorina spp ***H***					
Lottia gigantea ***HM***					
Haliotis cracherodii **L**					
Nucella canaliculata ***M***					
Nucella emarginata ***M***					
Ocenebra circumtexta ***M***					
Tegula funebralis ***L***					
Balanus glandula ***HM***					
Chthamalus fissus/dalli ***HM***					
Semibalanus cariosus ***M***					
Tetraclita rubescens ***M***					
Pollicipes polymerus ***HM***					
Ligia occidentalis ***H***					
Pachygrapsus crassipes ***M***					
Pisaster ochraceus ***L***					
Strongylocentrotus purpuratus ***L***					
Tar					

SOP # 5: Photographing Plots and Taking Area Photos

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) gives instructions for conducting the first portion of rocky intertidal site monitoring, taking digital photographs of the fixed plots and area (overview) photos while in the field. The second part in the monitoring, "Scoring the Photoplots," occurs subsequent to the completion of this protocol either in the field or office (SOP #6, #7 respectively). General camera use and quadrapod procedures are also discussed in this SOP.

I. General Survey Considerations using Digital Cameras

Digital cameras provide immediate feedback on image quality and simplify data management issues such as image organization, storage, and analysis.

Before departing for the field sites, all digital camera and sampling equipment (camera, housing, memory cards, quadrapod, etc.) are checked for good working order and are properly packed. Ensure that all rechargeable batteries are fully charged, memory cards are operational and empty (i.e., erased), and extra consumables like spare alkaline batteries and/or back-up memory card(s) are packed (SOP #1: Pre-season Preparations). For quality control purposes, check the camera settings (date, time, etc.). This information gets automatically stored with the jpeg and incorrect information would cause confusion when downloading.

Photoplots Photos

The monitoring objective for taking photoplot photographs is to provide a fine-scale photographic record using *fixed plots (photoplots)* as reference. These provide a visual record of the species composition and abundance for each plot, can be office scored for percent cover when field scoring is not performed, and secures a digital image record to allow for comparisons of plot change over time.

Procedure for Taking Digital Photographs of Photoplots (in Field)

1. Assemble quadrapod frame (Figure 5). Carefully mount camera in waterproof housing and secure.

2. Locate photoplots. It may be advantageous to first locate and mark all the plots with pin flags (i.e., survey flags) or flagging tape if personnel are unfamiliar with the site. Use

area photos, site maps, and/or distance and bearing measurements as needed to find troublesome plots (SOP #3: Establishing and Maintaining Plots).

3. Locate plot boundaries by identifying all plot corners. It is important that when searching for plot corners that you not disturb the way in which organisms lay in the plot. Photos should show algae or invertebrates in their original position. This is especially important in the rockweed (*Pelvetiopsis limitata*) zones. Moving rockweed will not only bias cover estimates, but organisms under canopy can suffer if shade and humidity microclimes are disturbed. Loose drift algae or other debris not attached to the substrate should be carefully removed from the plot.

4. *Verify* proper plot orientation using previous knowledge and/or site maps. Quadrat orientation just a few degrees off can provide false record of fixed plots. Remember that the four corners are subject to a lot of fouling! Do not assume positioning if marker is not visible. Locate and remove fouling or use reference photos to help locate and orient plots, especially when overgrowth is heavy or if plot corners have been dislodged/lost.

5. Place the quadrapod frame with the mounted camera over the plot, lining up the frame corners with the bolt markers, keeping the notched bolt in the upper left corner.

6. The quadrapod should set the camera in a flat view over the plot, reducing risks of parallax or depth of field distortions.

7. Site Code and Date are recorded in each photo on an erasable square slate, attached to the quadrapod frame, at the start of that day's sampling.

8. The plot type is also recorded on the erasable slate. Adjust the label at the base of the photoframer to reflect each plot label and number (e.g., M-1 for mussel plot #1). This label will appear in the top left of each photo as a fixed permanent record of plot number (in case photo is misnamed).

9. Check settings and, while camera is in picture taking mode, view LCD screen. Check that all frame corners are just visible at the photo's edge.

10. Hold the quadrapod steady and press camera's shutter trigger.

11. Record sequence of photos and relevant information, such as camera settings or encountered problems, on the "Rocky Intertidal Photodata Log" datasheet (Attachment F). This information is useful for later photo labeling and metadata procedures. Dominant species present can be recorded in the comment line for verification when scoring slides. Camera or strobe problems, misplaced or moved label slate, or anything else that might affect the photo should be noted in the Comment column.

12. Before moving on to the next plot, clean all the plot's corners (i.e., markers) of growth and note if epoxy needs to be repaired or replaced. This is noted in the Comment column of the Photodata Log datasheet.

13. Locate next plot and repeat procedures #2-12 above, until all photoplots at the site have been photographed. Double-check records to *verify* that all plots have been recorded.

14. Diassemble quadrapod and store camera (protect from heat and sun) and housing until you are ready to proceed with shooting area photos (procedure detailed below).

Note: Digital file labeling and image storage is treated in SOP# 12: Downloading Digital Photos and Photo Image Management.

Area (Overview) Photos

The monitoring objective of taking area photographs is to provide a habitat-level photographic record of the monitoring site using *photopoints* and *panoramics.* These provide a visual record of the overall site appearance and can record the relationship of fixed plots to the surrounding area, allowing for future comparisons of site change.

Photopoints consist of a few photographs from a specific vantage point. These are indicated on site maps. A standard vantage point is best for each point, though this varies with site and plot type. *Panoramics* include a panorama series of photos taken from specific reference points. Panoramas can be stitched together for broad views and even 360° views of the site.

In addition, digital records are also taken of anything "out of the ordinary," such as rock breakage or reef damage, poor organism health (bleached plants, dead barnacles, etc.), intrusion of sand (beach level, scour, or smothering effects), noticeable recruitment events, interesting aggregations of species, presence and extent of oil/tar, evidence of pollution, or human or feral animal impacts.

Procedures for Taking Digital Overview/Area Photos

1. Locate reference bolts and/or areas of interest for that site, which provide the necessary overview of the different habitats as described under "Photopoints" in the Site Description. Having printed copies of previously shot overview photos is helpful. Reference numbers (e.g., R1, R2) for the bolts may be written into the epoxy at the base of the bolt.

2. Using markers or bolts as reference, take necessary photos. Generally, the automatic setting on the camera will serve the purpose. Best results are obtained with a steady camera. Avoid shooting sky or sea as it will throw off the exposure and reduce the utility of the photograph.

3. Each Site Description may have a slightly varied Photopoint list, dependant upon the area's biological assemblages.

4. For panoramic photos, include sequential, overlapping habitat photos (i.e., "pans") taken (approximately 5-10 m way from reference point) while rotating the view area in a circular fashion (either clockwise or counterclockwise) from a fixed point marked with a reference bolt or epoxy. Keep the camera level and overlap approximately $^1/_3$ of the

image in each frame. Using a convention of panning left to right (or clockwise) and starting viewing to the north will aid labeling and give more consistent results.

5. Record notes on the Photodata Log datasheet. Indicate number of pans and rotation (clockwise) accordingly. Indicate area photopoints.

   Note: Digital file labeling and image storage will be the same as for photoplots and is addressed in SOP# 12: Downloading Digital Photos and Photo Image Management.

Figure 5. PVC photo framer for photographing permanent 50 x 75 cm plots. A camera and strobe (not shown here) are mounted to the top brackets to ensure accurate replicate size.

Attachment F. PhotoLog Datasheet.

Overview Photo Log

Site:_____ **Photographer:**_____

Date:_____

Overview #	# of photos taken	Notes (mistakes, etc.)

SOP # 6: Estimating Percent Cover in Field using Point-Intercept Method

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) summarizes the procedures for *field scoring* photoplots using a Fixed-Point Contact (FPC) method. This method estimates percentage cover of targeted organisms by scoring (tallying) 100 point-intercepts in a fixed plot (photoplot). Alternatively, plots may be scored in the lab or office using graphical software (SOP #7: Scoring Photoplots in Office (Using Graphical Software)); the same scoring rules shall be applied.

I. General Monitoring Considerations

The monitoring objective is to determine percent cover of organisms within fixed plots. These are the same fixed plots (interchangeably called photoplots or photoquadrats) that are photographed in the field (SOP #5: Photographing Plots and Taking Area Photos). Certain fixed plots are overlayed with a string-divided 50 cm x 75 cm quadrat and systematically field scored, identifying each organism that intercepts directly below 100 fixed points. Only barnacle plots are field scored since species of acorn barnacles (*Chthamalus dalli/fissus* and *Balanus glandula*) are more accurately scored in the field than in the office. This is mostly due to the difficulty, when scoring the photographs on the computer, in distinguishing between the two barnacle species and between alive and dead individuals.

For precision and accuracy, scoring rules must be applied and consistently followed to achieve a meaningful estimate of percent cover (see below). Remember that consistency and positive species identifications are crucial.

Scoring plots in the field requires that individuals be familiar with all species monitored. This includes target, core, and optional species (SOP #2: Training Field Workers, Appendix E). Some genera, especially algae, will look entirely different in different environmental conditions (e.g., heat stress) and in different seasons (e.g., reproductive versus non-reproductive). An alga that has dried may appear to have a different color and/or texture than a fully hydrated one. In the field, some species are difficult to distinguish or easily confused with others; photo plates in field guides do not always help to differentiate. First-hand, local species knowledge is important! When in doubt, ask and/or make a voucher collection. See the museum handbook for proper voucher procedures.

Over time, program objectives may result in alterations of some rules or the addition of some species for monitoring. Changes in scoring rules and species monitored will be documented with revised protocols (SOP #16: Revising the Protocol).

Equipment

The following equipment is needed to score photoquadrats in the field: polyvinyl chloride **(**PVC) scoring quadrat (divided in grid-like fashion), tally meter/s, photoplot scoring datasheet, and kneepads or gardening foam pads.

The field scoring frame is a rectangle, made of $^{3}/_{4}$ inch PVC pipe with partially-glued L-joints (one end only), finished to an inside dimension of 50 cm x 75 cm. Ten strings are permanently affixed (knotted) and stretched at regular intervals between the short-side (50 cm) dimension. This allows the frame to be disassembled for travel by rolling up the two 50 cm lengths with strings affixed and securing them to the removable longer lengths. The longer sides (75 cm) have glued L-joints and are also notched to hold a steel rod (width of notch/rod = $^{1}/_{32}$ inch) across the frame. Ten points are then created where the rod perpendicularly intersects the strings for each of the 10 notches on the frame, thus creating 100 point-intercepts (hence grid-like). These intercepts are scored sequentially at their point of intersection as the rod is moved along notched positions. Organisms lying directly beneath intercepts are identified and enumerated. Numbers are tallied by species on Photoplot Scoring datasheets (Attachment G). Kneepads or gardening pads are useful for protection when kneeling for close examination of the plot.

Procedure for Field Scoring Photoplots

1. Locate fixed plot boundary (same as photoplot) and the proper orientation carefully within the target species zone using previous site knowledge or appropriate site map (SOP #3: Establishing and Maintaining Plots).

2. Place the 50 x 75 cm frame (field-scoring frame, divided) on the plot in its proper orientation.

3. Using a multi-bank tally counter, with appropriate species designated to each tally, count species occurring directly below the point-intercept along the gridlines.

4. Follow the "**Scoring Rules**" as outlined below, without exception!

5. Keep careful checks on scoring method, making sure that tallies are applied to appropriate taxa. Not all species encountered will be stored on the bank tally. Therefore, a systematic tally system will need to be employed. Species presence and abundance will vary from plot to plot, so some adjustments will be necessary. Additional species may need to be tallied on the datasheet, for instance. Ask more experienced samplers about their methods, if necessary. Be sure to communicate effectively if using a data recorder.

6. It is best to work *methodically* (e.g., left to right, up to down) in whatever way works but in the same way each plot. This will help to retain memory and place as you work the 100 points.

7. Double check that the column is appropriately labeled with the correct plot number and that the column adds up to 100. Erase extraneous marks and make sure the numbers are legible.

8. Move to the next plot and repeat the procedure.

Rules for Scoring

Multi-layering of species will not be accounted for here (only topmost layer is scored). **A total percent cover in each plot will always be 100% total for all combined species (including rock and tar).** Notes can and should be made about epiphyte cover in the field. Plot sketches are helpful if scoring will be conducted in the office.

All organisms are identified to the lowest level possible. Use of a bank tally (3, or 8 counters in one) helps increase speed when counting multiple species. Having another person act as data recorder also improves efficiency. It is most helpful when the recorder is familiar with the species names and datasheet layout for ease of recording. Review the datasheet and species with him/her prior to field recording.

Organisms should be identified to the specific level when possible, though these may be "rolled up" into higher taxonomic classification for practical or comparative purposes on the datasheet (e.g., for analysis consistent with past data when level of identification was more general).

Conceptually, the points overlying the plot (in the field or the photo) should be imagined to be infinitely small (i.e., hits only one organism or substrate). Try to avoid changing perspective or errors associated with parallax.

1. **Always score the topmost (visible) layer that is attached to the substrate (i.e., not an obvious epibiont) unless the topmost layer is a "weedy" species obviously overlaying a non-weedy species.** This rule applies regardless of the target or core species involved. The rule was formulated to work consistently for scoring from photos in the lab (SOP #7: Scoring Photoplots in Office (Using Graphical Software)), supplemented when possible with rough plot sketches and brief notes. "Obvious" means that the layering can be discerned from the photograph or is clear from the brief field sketch/notes (e.g., a plot noted in the field to have 100% cover of mussels topped with weedy algae). Examples of epibionts include algae (e.g., coralline or non-coralline crusts, articulated corallines), red seaweed (*Endocladia spp.*), or invertebrates (e.g., barnacles, limpets) on live mussel shells or thatched barnacle (*Tetraclita rubescens*) tests. Examples of "weedy" species include various alga genera such as sea lettuce (*Ulva spp.*) and *Enteromorpha*, *Endarachne*, *Porphyra*, and *Scytosiphon*. The topmost rule eliminates much of the uncertainty of trying to determine what lies below the upper layer, does not bias for or against target species, and generally keeps the photograph as the primary source of archival data (rather than some difficult to reconstruct combination of photo, plot sketch, and/or field scoring). This method will underestimate target species cover whenever the target species is covered by another species (e.g., rockweeds (*Pelvetiopsis limitata*)) or any plant whose attachment lies outside the plot. Such situations should be noted and considered when evaluating data trends. Though desirable, scoring cover of understory target species is too complex and time-consuming to fall within the scope of this core monitoring protocol. Fortunately, layering is not a major issue for most target species, except in plots where rockweeds occur.

2. **Score sedentary motile invertebrates occurring under a photopoint as one of the following core categories: giant owl limpet (*Lottia gigantea*), limpet, chiton, ochre sea star *(Pisaster ochraceus*), or other invertebrate.** Since black abalone and purple urchins are rarely encountered (if at all) in photoplots, they have not been designated as core species for this protocol. If encountered, they would be scored as "other invertebrate." If an un-removed active motile invertebrate occurs under a photopoint, score what is likely underneath it if possible; otherwise, score the point as "unidentified" (do not score the active motile invertebrate as "other invertebrate"). For example, the herbivorous sea hare (*Aplysia californica)*, or the predatory dog whelks (*Nucella spp.*), should be counted as an active motile invertebrate, not scored as cover (e.g., sedentary other invertebrate).

3. **Score bleached crustose corallines (appearing white) as "crustose corallines," not "rock."** Bleached crustose corallines may still be alive (and may regenerate), so assume they are live and score as such.

4. **Score obviously dead barnacle tests, dead mollusk shells, etc. as "dead species" (e.g., dead acorn barnacle), unless they are covered by something (crustose algae, sponge), in which case they should be scored as the covering organism.** The rationale behind this is that dead shells and empty tests are substrates and not organisms at this point.

5. **Epoxy corner markers and bolts should be scored as "rock."**

6. **When sand is present under a point in the photo, if you can positively identify what is under the sand, score the underlying core species or "rock;" otherwise, score as "sand."** This means that "sand" will be scored whenever sand thickness is greater than just a thin layer with patches of rock or some core species showing through.

7. **Thin (i.e., not obvious) layers of cyanobacteria (blue-green algae) get scored as "bare rock." A noticeable *thick* mat of cyanobacteria would be scored as a "non-coralline crust."** Note that some rock types have mineral deposits that appear similar to non-coralline crusts in the photos. Look carefully; these should be scored as "bare rock" and NOT as "non-coralline crusts."

8. **An unknown species will be scored in one of these two categories: "*Other Algae*" or "*Other Invertebrate.*"**

Further Guidelines

1. If acorn barnacles (*Chthamalus spp.*) occur as an epibiont on thatched barnacles (*Tetraclita*), score the point as "Tetraclita."

2. If one species of rockweed overlays another species of rockweed, simply score the top layer as is, without moving either species. If a rockweed is obviously overlaying a mussel, score the rockweed because it is the top layer, is not an epibiont, and is not a "weedy" species.

3. **If plant species are attached outside the plot but draping over target or core species in the plot, score the overlying species (if it is not a "weedy" species) without regard to place of attachment.** For example, in the rare case where feather boa kelp (*Egregia*

menziesii) drapes across a mussel plot, leave it in place and score it as the top layer species (but note on the Sketch Datasheet what it is covering). Ideally, one would like to follow the target or core species, despite over-draping, but in practice it would be too complex for field samplers to record and would likely lead to inconsistencies.

Take notes in the field about the dominant species present (e.g., when mussels are under algae or what lies under a layer of "weedy species"). Also note where tar occurs, as some non-coralline crusts may be confused with tar in photos if scored later. If it is impossible to tell what lies below the "weedy species" or the weedy species is over rock, then simply record the point as the topmost layer (i.e., the weedy species).

Do not bias towards the target or core species haphazardly, but do keep in mind that the primary goal of targeting, for example, the mussel zone plots, is to track changes in mussel (*Mytilis spp.*) cover over time and not the annual changes in sea lettuce (*Ulva*) cover. Keep the target organism in mind when scoring rules fail.

Data are recorded on datasheet "Photoplot Scoring," regardless if scored in the field or the lab.

Procedure for Datasheet Management

1. At the end of the day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are filled in completely. Add any other notes as appropriate.

2. File the "Photoplot Scoring" datasheet with all other datasheets from the monitoring event in the appropriate Event Data Binder and file until data are entered.

3. Copies of the "Photoplot Scoring" datasheets will be delivered to the Network Data Manager at the Klamath Network office, where they will be scanned into one PDF document. The electronic file will be stored in the Intertidal project folder (Mohren 2007). The hardcopy copies of the field logs will be stored in a locked file cabinet.

III. Literature Cited

Mohren, S. R. 2007. Data Management Plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR—2007/012. National Park Service, Fort Collins, Colorado.

Attachment G. Photoplot Scoring Datasheet.

MARINE Photoplot Slide Scoring Datasheet

Site:_____ Sampling Season:_____ Date Sampled:_____

Assemblage:_____ Recorder:_____ Date

Taxa	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Cladophora					
Ulva/Entero.					
Pelvetia					
Pelvetiopsis					
non coralline crust					
Endocladia					
Mastocarpus					
Porphyra					
Mytilus					
Balanus					
Chthamalus					
dead Balanus					
dead Chtham					
Pollicipes					
Tetraclita					
Semibalanus					
dead Semibal					
limpet					
rock					
tar					

SOP # 7: Scoring Photoplots in Office (Using Graphical Software)

Version 1.00 (March 2007)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) summarizes the procedures for "*office scoring"* photoplots using the Fixed-Point Contact (FPC) method by aid of computer software. A graphics package (such as MS Photoshop) is used to overlay a grid of 100 regularly spaced, fixed points onto a digital plot record. An estimate of percent cover for the selected targeted organisms is obtained by scoring (i.e., identifying) what organism underlies (intercepts) each of the 100 points. For all plots that have not been scored in the field (SOP #6: Estimating Percent Cover in Field using Point-Intercept Method), this protocol is performed in the office upon return from a sampling event.

I. General Monitoring Considerations

Office scoring applies a computer-generated, 100 point grid over the digital record of the photoplot using suitable graphics software. This procedure requires extensive training and experience and for consistency is performed by a trained specialist.

The monitoring objective is to determine percent cover of organisms within fixed plots (interchangeably referred to as photoplots or photoquadrats). Plots are regularly documented (photographed) each monitoring season using a digital camera mounted on a quadrapod (SOP #5: Photographing Plots and Taking Area Photos). Then plots (in-situ or by digital record) are subject to a grid overlay to effectively estimate overall percent cover. Usually barnacle plots are scored in the field using a string-divided quadrat (SOP #6: Estimating Percent Cover in Field using Point-Intercept Method). For all other plot types, digital records of the plot will be scored back in the office. This SOP addresses considerations for scoring in the office setting.

Scoring plots in the office (or lab) requires individuals be familiar with all species monitored. This includes target, core, and optional species (Appendix E). Organisms may appear quite different in photographs compared to in their natural setting. Some species are easily confused with others in digital and/or film images, often appearing the same even with good photographic technique (e.g., proper exposure and depth of field).

For precision and accuracy, scoring rules must be applied and consistently followed to achieve a meaningful estimate of percent cover (see below). Remember that consistency and positive species identifications are critical.

While office scoring of photoplots may pose unique challenges, it has proven to be practical for saving time in the field and for consistency of data. Field scoring requires an experienced biologist or two and time in the field may be much more of a commodity than office time. Logistical constraints, including weather conditions and availability of daylight, may all reduce time spent in the field. For example, in high surf conditions, while it may be possible to shoot photos between wave sets, it may not be safe to spend time field scoring plots. Having a very experienced researcher score all of the photoplots maintains consistency in taxonomic identification and sampling methodology. This task will be completed by a lead biologist with training and experience in scoring photoplots.

Note that changes in scoring rules and/or species monitored will be documented with new protocols or revisions (SOP #16: Revising the Protocol).

Equipment:

The following equipment is needed to score photoplots in the office: downloaded digitized photo records of plots, a suitable computer workstation with installed graphics software (Photoshop Elements or Adobe Photoshop), field notes and/or sketches, a bank tally, a Photoplot Scoring datasheet, and a pencil.

Procedure for Office-Scoring Digitized Photo Records:

1. Open Photoshop 6 or a newer version.

2. Under "File," open "2x3 grid w/ 100 pts" (a file template made for this purpose).

3. Overlay the 100 point grid using cursor in select mode + to highlight (include the yellow outline that contains the 100 points).

4. Copy grid (Edit → Copy).

5. Open photo to be scored in Photoshop.

6. Paste grid onto photo.

7. To fit grid to the photo, go to Edit → free transform.

8. Move grid so that all points are within the plot but that the grid is at its maximum coverage. General rule of thumb is that the yellow border falls in the midline of the white PVC frame. (You can rotate grid if you click on the line at the corners.)

9. Hit Enter to apply the grid. Then you can apply/remove it by clicking on/off the layer window (grid is layer at this point).

10. Score the photo using the scoring rules. Zoom in and out of the quadrants (4) using the navigator window. Generally score at full view of one quadrant, with the ability to zoom in to points as necessary.

11. If points are too dark to score, select the point and go to Image →Adjust → Levels and move the middle arrow to adjust the level. You can save the adjusted level or not; sometimes this does not lend any help.

12. Using a multi-bank tally counter, with appropriate species designated to each tally, count species occurring directly below the 100 points.

13. Follow the rules for scoring, as outlined below, without exception!

14. Keep careful checks on scoring method, making sure that tallies are applied to appropriate taxa. Not all species encountered will be stored on the bank tally. Therefore, a systematic tally system of your choosing will need to be used.

15. It is best to work *methodically* (e.g., left to right, up to down) in whatever way works but in the same way for each plot. This will help to retain memory and place as you read the 100 points.

16. Transcribe data from bank tally to datasheet as you complete each plot. Be sure not to reset tally BEFORE data are transcribed to datasheet, otherwise you will have to rescore the 100 points!

17. Double check that the datasheet column is correctly labeled with the appropriate plot number and that the column adds up to 100. Erase extraneous marks and make sure all numbers are legible.

18. Once finished scoring, go to Layer → Merge visible (there should now only be one layer in the layer window).

19. Select File →Save As → jpeg (e.g., smch_myt1_401_sp05g.jpeg). In the file name, "g" indicates "grid," with a "g" placed at the end of the file name to differentiate the scored grid slide from the original. Procedures for naming photoplot files are described in SOP#12: Downloading Digital Photos and Photo Image Management.

20. Save a copy of the original photoplot record and a grid-overlayed record to the computer.

21. Move to the next photoplot record and repeat procedure.

Rules for Scoring

Check to see if any plot sketches (Sketch datasheet) or field notes were taken in the field that may assist in interpreting the photograph. In some cases, the Field Log or Photo Log

will have notes about the dominant species present, obscure or undifferentiated species, where tar occurs (as some non-coralline crusts may be confused with tar in photos if scored later), etc.

Multi-layering of species will not be accounted for here. **A total percent cover in each plot will always be 100% total for all combined species**.

All organisms are identified to the lowest level possible. Organisms should be identified to the specific level when possible, though these may be "rolled up" into higher taxonomic classification for practical or comparative purposes on the datasheet (e.g., for analysis consistence with past data when level of identification was more general).

Conceptually, the grid points overlying the plot image (in the photo) should be imagined to be infinitely small (i.e., hits only one organism or substrate). You may toggle grid layer On/Off to better see what lies directly underneath. It also works well to increase the grade-scale for "Transparency" of the grid layer to lighten but not remove the grid points.

1. **Always score the topmost (visible) layer that is attached to the substrate (i.e., not an obvious epibiont) unless the topmost layer is a "weedy" species obviously overlaying a non-weedy species.** This rule applies regardless of the target or core species involved. The rule was formulated to work consistently for scoring from photos in the lab and in the field (covered in SOP #6) supplemented when possible with rough plot sketches and brief notes. "Obvious" means that the layering can be discerned from the photograph or is clear from the brief field sketch/notes (e.g., a plot noted in the field to have 100% cover of mussels topped with weedy algae). Examples of epibionts include algae (e.g., coralline or non-coralline crusts, articulated corallines), red seaweed (*Endocladia spp.*), or invertebrates (e.g., barnacles or limpets) on live mussel shells or thatched barnacle (*Tetraclita rubescens*) tests. Examples of "weedy" species include various alga genera such as sea lettuce (*Ulva spp.)* and *Enteromorpha*, *Endarachne*, *Porphyra*, and *Scytosiphon*. The topmost rule eliminates much of the uncertainty of trying to determine what lies below the upper layer, does not bias for or against target species, and generally keeps the photograph as the primary source of archival data (rather than some difficult to reconstruct combination of photo, plot sketch, and/or field scoring). This method will underestimate target species cover whenever the target species is covered by another species (e.g., by rockweeds (*Pelvetiopsis limitata*)) or any plant whose attachment lies outside the plot. Such situations should be noted and considered when evaluating data trends. Though desirable, scoring cover of understory target species is too complex and time-consuming to fall within the scope of this core monitoring protocol. Fortunately, layering is not a major issue for most target species, except in plots where rockweeds occur.

2. **Score sedentary motile invertebrates occurring under a photopoint as one of the following core categories: giant owl limpet (*Lottia gigantea*), limpet, chiton, ochre sea star *(Pisaster ochraceus*), or other invertebrate.** Since black abalone and purple urchins are rarely encountered (if at all) in photoplots, they have not been designated as core species for this protocol. If encountered, they

would be scored as "other invertebrate." If an un-removed active motile invertebrate occurs under a photopoint, score what is likely underneath it, if possible; otherwise, score the point as "unidentified" (do not score the active motile invertebrate as "other invertebrate"). For example, the herbivorous sea hare (*Aplysia californica)* or the predatory dog whelks (*Nucella spp.*) should be counted as an active motile invertebrate, not scored as cover (e.g., sedentary other invertebrate).

3. **Score bleached crustose corallines (appearing white) as "crustose corallines,, not "rock."** Bleached crustose corallines may still be alive (and may regenerate), so assume they are live and score as such.

4. **Score obviously dead barnacle tests, dead mollusk shells, etc. as "dead species," unless they are covered by something (e.g., crustose algae, sponge), in which case they should be scored as the covering organism.** The rationale behind this is that dead shells and empty tests are substrates and not organisms at this point.

5. **Epoxy corner markers and bolts should be scored as "rock."**

6. **When sand is present under a point in the photo, if you can positively identify what is under the sand, then score the underlying core species or "rock;" otherwise score "sand."** This means that "sand" will be scored whenever sand thickness is greater than just a thin layer with patches of rock or some core species showing through.

7. **Thin (i.e., not obvious) layers of cyanobacteria (blue-green algae) get scored as "bare rock." A noticeable *thick* mat of cyanobacteria would be scored as a "non-coralline crust."** Note that some rock types have mineral deposits that appear similar to non-coralline crusts in the photos. Look carefully; these should be scored as "bare rock" and NOT "non-coralline crusts."

8. **An unknown species will be scored in one of these two categories: "*Other Algae*" or "*Other Invertebrate.*"**

Further Guidelines

1. If acorn baracles (*Chthamalus spp.*) occur as epibionts on thatched barnacles (*Tetraclita*), score the point as "Tetraclita."

2. If one species of rockweed overlays another species of rockweed, simply score the top layer as is. If a rockweed is obviously overlaying a mussel, score the rockweed because it is the top layer, is not an epibiont, and is not a "weedy" species.

3. **If plant species are attached outside the plot but draping over target or core species in the plot, score the overlying species (if it is not a "weedy" species) without regard to place of attachment.** For example, in the rare case where feather boa kelp (*Egregia menziesii)* drapes across a mussel plot, leave it in place and score it

as the top layer species (but note on the Sketch datasheet what it is covering). Ideally one would like to follow the target or core species despite over-draping, but in practice it would be too complex for field samplers to record and would likely lead to inconsistencies.

Do not bias towards the target or core species haphazardly, but do keep in mind that the primary goal of targeting, for example, the mussel zone plots, is to track changes in mussel (*Mytilis spp.*) cover over time and not the annual changes in sea lettuce (*Ulva*) cover. Keep the target organism in mind when scoring rules fail.

Data are recorded on datasheet "Photoplot Scoring." (Attachment H). Be sure to indicate where scored as office (O).

Procedure for Datasheet Management

4. Upon completion of office scoring, check that the datasheet is legible and all headers are completely filled in. Make added notes as appropriate.

5. Scan the completed datasheet to a digital Adobe PDF document and store in the appropriate folder in the TIDEPOOL directory. Check legibility of image file.

6. File the "Photoplot Scoring" datasheet with all other datasheets from the monitoring event in the appropriate Event folder and file in master filing cabinet.

7. The PDF and images will need to be transferred to the Klamath Network following the procedure and timeline in SOP #17: Project Deliverables.

Attachment H. Photoplot Scoring Datasheet for Office Scoring Photoplots.

Site:_____ Sampling Season:_____Date Sampled:_____
Assemblage:_____ Recorder:_____Date Scored:_____

Core Taxa*		Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Cladophora columbiana	CL					
Ulva/Enteromorpha	UE					
Other Green Algae	OG					
Egregia menziezii	EM					
Fucus gardneri	FG					
Hesperophycus californicus	HE					
Pelvetiopsis limitata	PL					
Scytosiphon spp	SC					
Silvetia compressa	SI					
Hedophyllum						
Other Brown Algae	OB					
Endocladia muricata	EN					
Chond. canaliculatus canaliculatus (= Gigartina canaliculata)	CO					
Mastocarpus papillatus	MP					
Mazzaella affinis	MZ					
Mazzaella spp	MS					
Porphyra sp	PS					
Articulated corallines	AC					
Crustose corallines	CC					
Neorhodomela						
Gelidium						
unidentified						
Other Red Algae	OR					
Phyllospadix scouleri/torreyi	PY					
Non-coralline crusts	NC					
A. elegantissima/sola	AE					
Phragmatopoma californica	PH					
Mytilus californianus	MY					
Lottia gigantea	LG					
Limpets	LI					
Chitons	CI					
Chthamalus spp/Bal glandula	CB					
Tetraclita rubescens	TR					
Pollicipes polymerus	PO					
Semibalanus						
Other Barnacles	BA					
Pisaster ochraceus	PI					
Other Invertebrates	OI					
Rock	R					
Sand	S					
Unidentified						

SOP # 8: Motile Invertebrate Counts

Version 1.00 (February 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) summarizes the procedures for conducting motile invertebrate counts using established monitoring protocols and for recording data to the "Motile Invertebrates for Northern MARINe Sites" datasheet (Attachment I). Target species or species groups (Table 4) are monitored regularly at Redwood National and State Parks (RNSP). Motile counts are collected during summer and winter sampling events.

I. General Survey Considerations

The target motile invertebrates are small, mostly herbivorous or scavenger predators. They likely respond differently than benthic organisms monitored in photoplots (which are mostly autotrophs or filter feeders) to changes in climate, severe weather, pollution (especially oil spills), alien species invasion, disease, or disruption of the ecosystem by resource extraction. For example, changes in abundance due to predation in the intertidal zone by alien rats on crabs and snails are tracked by this type of monitoring.

This protocol measures relative abundance (rather than absolute) since cryptic or small sized individuals in complex-structured plots are likely overlooked in counting (e.g., the periwinkle (*Littorina spp.*) and small limpets are especially difficult to see on certain rock types). Density variability (e.g., aggregating behavior) suggests that relative numbers are more important in determining population abundance and system functioning than absolute numbers. The monitoring objective is to determine relative densities of snails, chitons, limpets, and crabs for annual comparisons. Invertebrate densities may serve as an indicator of overall or specific ecosystem health.

SOP #8: Motile Invertebrate Counts (continued).

II. Species Monitored

Table 4. . Species list of targeted motile invertebrates monitored at RNSP. Core species are those that are always enumerated in all MARINe programs counting motile invertebrates, while optional species are those that we have chosen to identify and enumerate when encountered in plots at RNSP.

Core species
Acanthina spp.
Ocenebra circumtexta
Tegula funebralis
Tegula brunnea
Tegula gallina
Nucella emarginata
Nucella canaliculata
Lottia gigantea
Fissurella volcano
Mopalia spp.
Nuttalina spp.
Lepidochitona spp.
Pachygrapsus crassipes
Pagurus spp.
Littorina spp.
Limpets (all spp. excluding *Lottia gigantea*)

Optional species
Amphissa versicolor
Epitonium tinctum
Ceratostoma nuttalli
Haliotis cracherodii
Haliotis fulgens
Pagurus samuelis
Pagurus hirsutiusculus
Pagurus granosimanus
Pisaster ochraceus
Pisaster giganteus
Patiria miniata
Leptasterias hexactis
S. purpuratus
S. franciscanus
Mexacanthina lugubris
Stenoplax spp.
Tonicella lineata
Lepidozona spp.

III. Procedures

Established fixed photoplots previously sampled for percent cover (SOP #5: Photographing Plots and Taking Area Photos) are re-sampled for this protocol. No additional plots are monitored. Field equipment necessary to count motile invertebrates includes: 50 cm x 75 cm quadrat frame (same as used for photoplots, but without dividing strings), a 10 cm x 10 cm wire frame (for sub-sampling), a 20 cm x 20 cm wire frame (for sub-sampling), kneepads, calipers, long forceps (helpful in picking up snails from crevices), and "Motile Invertebrates for Northern MARINe Sites" datasheet**.**

Completing this protocol is fairly labor intensive. This method has been tested and compared to complete counts. It was decided that overall numbers (and size class structure in the case of limpets) was adequate for general monitoring for periwinkles and limpets.

Procedure for Conducting Motile Invertebrate Counts

1. Locate photoplots using the appropriate site map (SOP #3: Establishing and Maintaining Plots).

2. Place a 50 cm x 75 cm frame over the photoplot.

3. Systematically search the entire plot, counting all individuals of species listed on the datasheet. Some species will require sub-sampling (see Procedures below). While searching through the plot, algae may have to be moved aside, especially in rockweed plots. For this reason, ***it is best to shoot photos and field score plots before counting motile invertebrates.*** It often works best to conduct multiple searches, concentrating search images by counting only one or two species at a time. Target invertebrates can be removed from plots and placed in a container for counting and/or measuring but should be returned to the specific plot when sampling is completed. Plastic forceps have proved useful for extracting whelks from crevices and from amongst mussels.

4. Use tally marks on the datasheet to keep track of number of each taxon. Having someone record the data for the observer helps with efficiency and minimizes recording errors.

5. Organisms are all identified to species level when possible, except periwinkles (*Littorina* spp) and limpets. For enumeration purposes, all limpets except the owl limpet (*Lottia gigantea*) are lumped together as either small (<5 mm), medium sized (5-15 mm), or large (>15 mm), due to the excessive time and skill involved with identification to species level. Do not forget in the count data that this size class information is collected for limpets.

Procedures for Sub-sampling Motile Invertebrates in Plots

1. Three replicate sub-samples comprise a "sub-sample." Limpets are placed into three size categories (small: <5 mm, medium: 5-15 mm, and large: >15 mm). Small and medium limpets (all species except owl limpets (*Lottia gigantea*)) are sub-sampled when numerically abundant, using a 20 cm x 20 cm wire frame in the upper left, center, and lower right corners of the photoplot. Search carefully, as tiny limpets may at first appear

as little more than dark specks on the rock. (Note: large limpets are recorded separately at the top section of the datasheet.)

2. Periwinkles *(Littorina spp*) are sub-sampled in 10 cm x 10 cm frames within the upper right corner of each 20 cm x 20 cm frame (resulting in three sub-samples).

Procedure for Collecting Length Data

1. Length frequencies of certain snail genera *(Nucella, Acanthina, Tegula,* and *Ocenebra*) are collected by measuring the first 10 individuals encountered in each plot.

2. Record the sizes, to the nearest millimeter, in each column and write the total number in the narrow box on the left of each column. Circling the total number on the datasheet helps identify it from tallies and sizes.

Procedures for Quality Assurance

1. While still at the site, each datasheet is checked for missing information and legibility. This is best if done by someone other than the recorder. Any questions about shorthand symbols or notation should be clarified immediately with the recorder and included with the notes. Be sure that total numbers are distinct from tally marks or partial counts (it is good practice to circle totals and always circle or underline 11 to distinguish from two tally marks).

2. Any variation to the normal protocol should be noted on the daily log and briefly on the datasheet itself. Transcribe any notes made on slates or other datasheets so that all information pertinent to this protocol is kept together.

3. Make sure sub-sampling methods are clear. Clearly note any unidentified or questionable species, and if possible, collect a voucher specimen for proper identification. As mentioned in a SOP#6: Estimating Percent Cover in Field using Point-Intercept Method, refer to the NPS museum handbook for voucher procedures. Once identification is made, make the note on all applicable datasheets and copies.

Procedure for Datasheet Management

1. At the end of the day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are completely filled in. Add any other notes as appropriate.

2. File the "Motile Invertebrates" datasheet with other datasheets from the specific monitoring event in the appropriate data binder and file in the appropriate location.

3. The data will need to be transferred to the KLMN following the procedure and timeline in SOP #17: Project Deliverables.

Attachment I. Mobile Invertebrates for Northern MARINe Sites

Plot Type:_____ Site:_____

Counter:_____ Date:_____

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Species counted in whole plot (can be sub-sampled if abundant)* For hermits, I.D. 1st 10 & multiply % by total.					
Lepidochitona hartwegii					
Nuttalina spp.					
Mopalia spp.					
Lepidochitona dentiens					
Pachygrapsus crassipes					
Pagurus samuelis					
Pagurus hirsutiusculus					
Pagurus granosimanus					
Ocenebra circumtexta					
Large limpets (>15mm) (excluding L. gigantea)					

Species counted and measured (1st 10 encountered only) in whole plot (can be sub-sampled if abundant)*										
	#	sizes	#	sizes	#	sizes	#	sizes	#	sizes
Nucella emarginata										
Nucella canaliculata										
Acanthina spp.										
Tegula funebralis										
Lottia gigantea										

Species sub-sampled in 3 20 x 20 cm quadrats placed in UL, middle & LR of plot** Count limpets on rock (R) and mussels (M) separately.																
	R		M		R		M		R		M		R		M	
limpet <5 mm																
limpet 5-15 mm																
Sample in 10 cm x10 cm section of 20x20 cm quadrat**																
Littorina spp.																

Optional Species (count if present)
Tegula brunnea
Tegula gallina
Amphissa versicolor
Epitonium tinctum
Ceratostoma nuttalli
Haliotis cracherodii
Haliotis fulgens
Pisaster ochraceus
Pisaster giganteus
Patiria miniata
Leptasterias hexactis
S. purpuratus
S. franciscanus
Mexacanthina lugubris
Stenoplax spp.
Tonicella lineata
Lepidochitona spp.
Lepidozona spp.
Fissurella volcano

* If plots are sub-sampled, multiply # out and record count for whole plot.

** Do not multiply # out for these spp., just note sub-sampled area if different from that listed so #s can be converted in lab.

UCSC 05/11/06

SOP # 9: Sea Star Monitoring

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) summarizes the procedures for conducting sea star monitoring using established monitoring protocols. Sea star monitoring will be conducted twice annually, each summer and fall, during the regular monitoring visit. The ochre sea star (*Pisaster ochraceus*) is the target species for size frequency measurements. All other sea star species will be noted if they are found. These species include *Patiria miniata*, *Pisaster giganteus*, and *Pycnopodia helianthoides*. Rarer species of sea stars such as *Leptastarias hexactis* and *Dermasterias imbricata* are also noted when seen. This SOP summarizes procedures for: 1) conducting irregular plot surveys and 2) completing "*Pisaster* Size Frequency Datasheet" (Attachment J).

I. General Survey Considerations

Sea stars are important predators in the rocky intertidal community. Populations can be highly variable and mobile. Standard procedures involve intensive searching in irregular plots, checking in cracks and crevices, and carefully counting individual sea stars. Sea stars have been susceptible to a wasting disease in Southern California during warm water years. This is usually identified by missing arms with frayed, rotten tissue or just a general look of soft, rotten flesh. Any observations of diseased sea stars should be noted on the field log.

Protocols are adapted from the MARINe Handbook in order to create plots comparable over a large geographic range (Engle 2005). The plots are irregular in shape, encompassing an area with high densities of sea stars. These plots are not intended to quantify densities at an overall site, but are meant to provide discrete plots where abundance and size distribution of sea stars can be monitored over time. Irregular plots are marked by four or more "corner" bolts, one of which is notched with the plot number. The plots are placed in areas of high sea star density to obtain as many counts and measurements for size frequency as possible**.**

To survey a plot, at sufficiently low tide, a meter tape is laid out around the irregular plot perimeter and the entire area encompassed by the boundary tape is carefully searched. All sea stars within the plot are recorded while only ochre sea stars (*Pisaster ochraceus*) are measured. Ochre sea stars (*Pisaster ochraceus*) are recorded if any part of the animal is inside the plot. Each sea star is temporarily marked with yellow forestry chalk to avoid duplicate counts.

II. Plot Selection

Three permanent plots were established at each of our rocky intertidal sites to monitor the size and abundance of sea stars. Plots have been established and monitored at all three RNSP sites in locations where both 1) ochre sea stars (*Pisaster ochraceus*) were consistently found in relatively high numbers and 2) the plots could be re-established each year.

Because sea stars are typically found in exposed locations with high mussel growth, locating transect markers may be difficult. The use of detailed maps, interplot measurements, and overview photos is necessary for locating plots. Sea star aggregations often move across the reef so that fixed plots may detect more variability than is actually present.

III. Procedures

Procedure for Fixed Irregular Plot Search for Sea Stars

1. Locate irregular plots. Stretch a meter tape around the permanent bolts to outline the perimeter of the plot.

2. The defined plot is surveyed for the presence of sea stars.

3. Ochre sea stars are measured with a ruler from the center of the disc to the tip of the longest ray to the nearest 5 mm for animals <10 mm and the nearest 10 mm for larger sea stars. Often sizes have to be estimated because sea stars are wedged in tight spots with rays curved. A flashlight is used to see in cracks and overhangs. Sea stars are never "straightened" or removed from the rock.

4. The color category (Purple/Other or Orange) is recorded for ochre sea stars.

5. Other species of sea stars are enumerated only.

6. Once recorded, sea stars are temporarily marked with a forestry crayon to avoid double counting.

7. Size measurement and species are recorded directly to the "*Pisaster* Size Frequency Sheet." Usually one or two people search for stars and one person records measurements.

8. While still at the site, each datasheet is checked for missing information and legibility. This is best if done by someone other than the recorder. Any questions about shorthand symbols or notation should be clarified immediately with the recorder and included with the notes. Any variation to normal protocol should be noted briefly on the datasheet itself and on the daily log. Transcribe any notes made on slates or other datasheets so that all information is kept together.

Procedure for Datasheet Management

1. At the end of the day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are completely filled in. Add any other notes as appropriate.

2. File the "*Pisaster* Size Frequency Sheet" with all other datasheets from the monitoring event in the appropriate data binder.

3. At the end of the field season, copies of the datasheets will be delivered to the Klamath Network Data Manager at the Network office, where they will be scanned into one PDF document. The electronic file will be stored in the Intertidal project folder (Mohren 2007). The hardcopy copies of the datasheets will be stored in a locked file cabinet.

4. The data will need to be entered into the MARINe database at the end of the season (SOP #14: Data Entry and Management Including Uploading to MARINe Database) and a copy of the database will be transferred to the Klamath Network following the procedures and timeline in SOP #17: Project Deliverables.

IV. Literature Cited

Engle, J. M. 2005 update. Unified monitoring protocols for the Multi-Agency Rocky Intertidal Network. OCS Study MMS 05-01.

Mohren, S. R. 2007. Data management plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR--2007/012. National Park Service, Fort Collins, CO.

Attachment J. *Pisaster* Size Frequency Sheet.

Site:_____ Recorder:_____

Date:_____ Sampler:_____

PISASTER

Size	**Plot 1**		**Plot 2**		**Plot 3**	
Radius (mm)	Purple/ Other	Orange	Purple/ Other	Orange	Purple/ Other	Orange
5						
10						
20						
30						
40						
50						
60						
70						
80						
90						
100						
110						
120						
130						
140						
150						
160						
170						
180						
190						
200						

Other Seastars (total # only, no sizes)

Species	**Plot 1**	**Plot 2**	**Plot 3**

SOP # 10: Surfgrass Monitoring

Version 1.00 (February 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) summarizes the procedures for conducting surfgrass transect monitoring using established monitoring protocols. Surfgrasses (*Phyllospadix scouleri* and *Phyllospadix torreyi*) are the target species. Monitoring is conducted twice yearly, each summer and fall/winter. This SOP summarizes procedures for conducting surfgrass transect monitoring and for recording data to the "Surfgrass Point Intercept Transect" datasheet (Attachment K).

I. General Survey Considerations

Surfgrasses are considered sensitive species because of their vulnerability to disturbance, particularly oil spills, and their importance for providing habitat for many species of fishes and invertebrates. Two species of surfgrass (*Phyllospadix scouleri* and P. *torreyi)* occur in our area. These may be intermixed with species coralline algae, feather boa kelp (*Egregia menziesii*), and a number of red algae. Surfgrass often becomes abraded or bleached and will seasonally die back. Surfgrass may be torn out by heavy surf or other disturbance to the intertidal, or may be replaced by other colonizing species. The monitoring objective is to determine changes in surfgrass zone by observing cover along fixed point-intercept transects. Thickness of surfgrass is also measured at 10 points along each transect to determine changes in the density of surfgrass.

II. Plot Selection

Transects are 10 m long and were established in the surfgrass zone where one or both species of surfgrass were the dominant cover. Ideally the start and end of each transect (and even the middle point) have a high spot where a bolt can be placed and easily found again. Areas of high wave impact should be avoided, as should deep tidepools.

A list of established permanent surfgrass transects in RNSP is given in Table 5.

Table 5. Monitoring sites with permanent surfgrass transects, dates established, and the number of replicates.

Site Name (Site Abbreviation)	Date established	Number of transects
Damnation Creek (DMN)	2004	2

III. Procedures

In order to establish or monitor transects, you will need a meter tape, a compass (for laying the tape, especially if both end bolts are not found), and a Surfgrass Point-Intercept Transect Datasheet.

Procedure for Establishing a (New) Surfgrass Transect

1. Two or three 10 m transects should be established in relatively dense surfgrass assemblages.

2. Drill reference bolt holes and epoxy stainless steel bolts (6 inch or larger) into the rock, preferably at high spots at each end of the 10 m transect.

3. One bolt from each transect (usually closest to shore) is notched with its number, 1, 2, or 3, to identify the transect number and starting point. An additional bolt may be permanently affixed in the center of the transect line to aid in location. However, do <u>not</u> notch this one.

4. Carefully measure distance and bearing of the transect ends to the other adjacent plot markers and describe the orientation and placement of each transect. Note the bearing of each transect bolt in reference to its other end. Record and document.

Procedure for Conducting Existing Surfgrass Transect Monitoring

<u>Note</u>: Sampling is best performed at the lowest point in the day's tidal cycle.

1. Locate transect line bolts. Clean and repair, as needed.

2. Lay the meter tape out taunt between the bolts. Be careful not to disturb the position of plants (canopy) along transect. Verify compass bearing to site map.

3. Each transect is scored (see "Rules" below) for species occurrence under distinct 100 point-intercepts uniformly distributed at 10 cm intervals (10 cm, 20 cm, 30 cm, and so on, until 1000 cm) along the meter tape.

4. The accepted standard method to record a species intercept has been to record the number of occurrences, or hits, by each species (essentially an estimate of percent cover), regardless of order found. Though recording each point in order would essentially map distributions each time, it has been found to be much slower.

5. Observers must be able to identify the various cover species on a transect. Refer to the Surfgrass Point-Intercept Transect datasheet (Attachment K) for taxa recorded.

6. If possible, calling out the species at each point-intercept to a data recorder improves efficiency and reduces potential for recording error. A tally is kept next to the appropriate taxa for each point-intercept.

7. Perform quality control on data recorded while still on site. Make sure 100 points were read. Check datasheet for missing information and legibility. This is best if done by someone other than the recorder. Any questions about shorthand symbols or notation should be clarified immediately with the recorder and included with the notes. Any variation to the normal protocol should be noted on the daily log as well as stated briefly on the datasheet. Transcribe any notes made on slates or other datasheets so that all information pertinent to this protocol is kept together.

"Rules for Scoring" (Note: Surfgrass scoring is similar to scoring Photoplots)

1. Each of the 100 points along the transect meter tape is located and scored as one of 22 categories (Attachment K) of core species, higher taxa, or substrates.

2. Only the topmost (visible) layer that is attached to the substrate (e.g., not an obvious epibiont such as the alga *Enteromorpha* or *Smithora*) is scored, except that surfgrass is also scored separately when it is covered by another non-epibiont species (see below).

3. *Phyllospadix spp.* is scored in either of two categories*: **"***Phyllospadix* Overstory," or "*Phyllospadix* Understory."

*Note: This procedure documents surfgrass even when it is covered by another species. Total transect cover will be **greater** than 100% when understory (e.g., feather boa kelp (*Egregia menziesii)* is lying across surfgrass (*Phyllospadix spp.*) on the point) surfgrass is scored. Since any amount >100% cover represents understory surfgrass only, compatibility with previous "top layer only" scoring is maintained. Scoring other understory species, though possible in the field, would be tedious and impractical given personnel and time constraints, especially when transects are periodically awash.

4. Additional (optional) taxa can be used but must be rolled up into higher taxa for data entry. Optional species, once stated, should be scored consistently (all transects) for the monitoring event.

5. Abundance (none, low, medium, high) of the epiphytic alga *Smithora* and *Melobesia*, and overall condition of surfgrasses (e.g., bleached and abraded appearance, brown, presence of flowers), are categorized for the overall transect area.

6. Surfgrass thickness is scored in the center of each meter along the transect (10 points total). Thickness is measured by pinching the clump of surfgrass in the center of each meter and using calipers to measure the thickness of the clump. Calipers should be closed gently around the clump, but not squeezed so much that they flatten the clump.

7. Record any other pertinent notes or unique findings.

Procedure for Datasheet Management

1. At the end of the day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are completely filled in. Add any other notes as appropriate.

2. File the original Surfgrass Point-Intercept Transect Datasheet with all other datasheets from the monitoring event in the appropriate data binder.

3. At the end of the field season, copies of the datasheets will be delivered to the Klamath Network Data Manager at the Network office, where they will be scanned into one PDF document. The electronic file will be stored in the Intertidal project folder (Mohren 2007). The hardcopy copies of the datasheets will be stored in a locked file cabinet.

4. The data will be entered into the MARINe database (SOP #14: Data Entry and Management including Uploading to MARINe Database) at the end of the season and a copy of the database will be transferred to the Klamath Network following the procedures and timeline in SOP #17: Project Deliverables.

IV. Literature Cited

Mohren, S. R. 2007. Data management plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR--2007/012. National Park Service, Fort Collins, CO.

Attachment K. Surfgrass Point-Intercept Transect Datasheet.

Site:_____Date:_____Time:_____Sampler:_____
Recorder:_____
Directions: Record 100 point-intercepts (every 10 cm) along 10m transect lines.

Category	Species	Transect 1	Transect 2	Transect 3
Phyllospadix	overstory			
	understory			
Egregia menziezii				
Eisenia arborea				
Halidrys/Cystoseira				
Sargassum muticum				
Neorhodomela larix				
Mazzaella spp.				
Crustose	coralline			
	non-coralline			
Articulated corallines				
"Turf"	filamentous red			
	C. canaliculatus			
	Gastroclonium			
	Gelidium			
Other algae	red			
	brown			
	green			
Anthopleura elegantissima/sola				
Phragmatopoma californica				
Mytilus californianus				
Barnacles				
Pisaster ochraceus				
Other inverts				
Rock				
Sand				
Other				
Total:				
Approx. % cover of *P. torreyi*				
Approx. % cover of *P. scouleri*				

Surfgrass Thickness

Transect	1	2	3	4	5	6	7	8	9	10
1										
2										

SOP # 11: Temperature Loggers

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) summarizes the procedures for deploying and maintaining temperature loggers in the Rocky Intertidal Monitoring Program at Redwood National and State Parks (RNSP).

I. General Considerations

Intertidal Temperature Loggers

Intertidal temperature loggers are deployed at each of the RNSP sites**.** These small units ("Stowaways," "Tidbits," or "Pendants" from Onset Corporation, see Figure 6) record automated ambient temperatures (sea or air depending on tide height) at pre-set time intervals (usually every 15 minutes). Typically they are housed in capped PVC tubes or wire mesh cages and bracketed to the rock in the mid-mussel zone or just below the mussel zone. The units are changed out (or downloaded to an "Optic Shuttle") during each monitoring survey. After data are downloaded, the unit can be reset to use again. Battery life for the approximately $120 Tidbits is about five years; once batteries fail, units are discarded. Battery life for the approximately $50 Pendants is about one year; battery can be replaced by user. Start use dates should be noted and units (Tidbit) or batteries (Pendant) replaced after end of specified battery life span to prevent loss of data. Data managers can process the temperature records to separate submerged periods from times when the units are exposed to air.

First, the data logger is connected to a personal computer. Then the turn-key software (Box Car Pro) is used to select logging parameters (sampling intervals, start time, etc.) and initiate the logger. A delayed start can be programmed for the date of sampling. The logger is then disconnected and deployed in the desired location. The logger records each measurement and stores it in memory along with the time and date. The logger is then reconnected to the personal computer and the software is used again to readout the data and to display the measurements as a graph, showing the profile over time (Figure 7). The tabular data can be viewed or exported to a spreadsheet for further manipulation.

Procedures for Deploying a New Temperature Logger

1. Select a site near the lower edge of a mussel bed that has enough surface area to mount the temperature logger housing. The site should not be in an area of potential foot traffic

or be obvious to people walking by. The temperature logger should not be covered by overhanging canopy.
2. Determine housing placement and mark areas where screws will fasten housing to rock. Drill necessary holes in rock to secure housing with a rotary hammer drill and $^{3}/_{8}$ inch drill bit.
3. Secure temperature logger in housing with zip ties.
4. Use a handheld speed wrench to secure the screws in the pre-drilled holes and tighten down the temperature logger housing. Plastic PVC washers may help to secure the screws.
5. Draw a detailed map and take overview pictures of the temperature logger location to make finding it on subsequent trips easy.

Procedures for Downloading and Re-deploying a Temperature Logger

1. During each sampling trip, locate the temperature logger housing.
2. Remove the zip ties securing the current temperature logger to the housing and take out the temperature logger.
3. Examine the temperature logger for any obvious signs of damage and remove excessive growth (e.g., algae and invertebrates).
4. Either swap out the temperature logger for a new programmed logger or download the temperature logger with an "optic shuttle."
5. Record the serial number of the logger on the field log datasheet.
6. Replace the new or downloaded temperature logger in housing and secure with zip ties. Double check that housing is still secure.
7. Offload data from data logger or optic shuttle onto a computer using the data shuttle, as soon as possible after sampling trip.
8. The software program BoxCar Pro is used to download temperature logger data (Figure 7).

Procedure for Datasheet Management

1. Each temperature logger serial number and date of data offload is entered into a log. A file of temperature data from each site is stored in the computer network.
2. Temperature data files will be delivered to the Klamath Network Data Manager. An electronic file will be stored in the Intertidal project folder (Mohren 2007).
3. Data will be transferred to the Klamath Network following the procedures and timeline in SOP #17: Project Deliverables.

Figure 6. Photos of Onset brand temperature logger (top) and wire mesh temperature logger housing deployed at intertidal site (bottom).

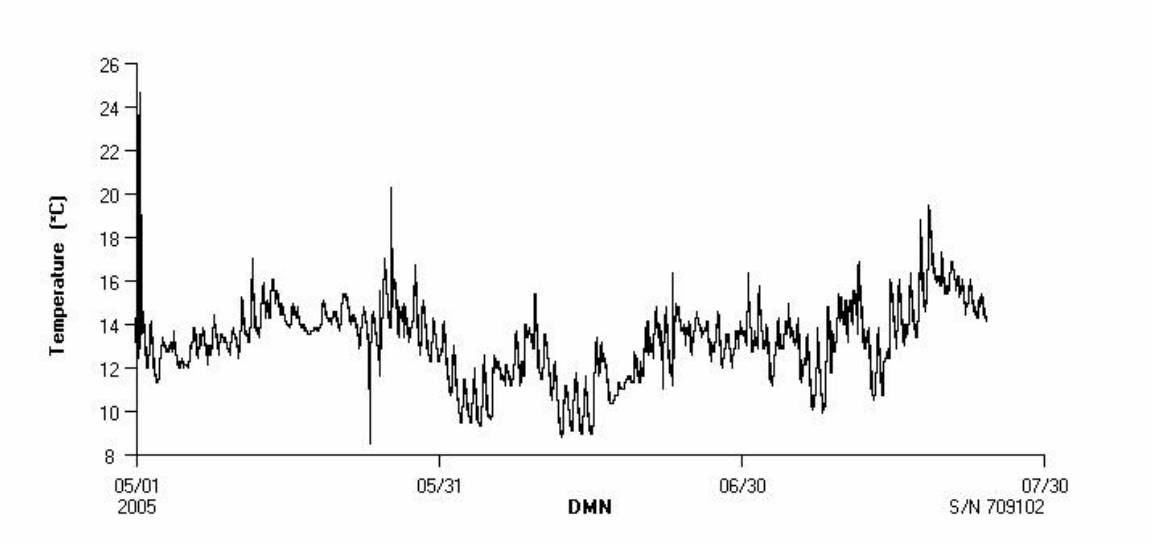

Figure 7. Example readout of temperature graph recorded from Onset temperature logger using Program Boxcar Pro.

II. Literature Cited

Mohren, S. R. 2007. Data management plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR--2007/012. National Park Service, Fort Collins, CO.

SOP # 12: Downloading Digital Photos and Photo Image Management

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) provides specific procedures for the downloading of digital images following photograph documentation of photoplots in the field (SOP # 5: Photographing Plots and Taking Area Photos). The SOP provides details on how to download images, how to properly name images, and how to back up and/or archive photo records. The metadata that will accompany digital images is defined. However, metadata procedures will be more completely addressed in SOP #13: Metadata Guidelines.

I. General Considerations for Digital Records

Digital records are the preferred image media. Digital imagery refers to electronic images obtained using digital cameras. This section covers the download and naming of digital camera files from an Olympus C-5050 camera, but procedures should apply to most digital cameras and computers operating in the Microsoft XP operating system and having a Universal Serial Bus (USB) port connection. Consult specific equipment operating manuals and/or software user manuals as needed.

When taking images, you should adhere to the following guidelines (Mohren 2007):

1. The Klamath Network (KLMN) requires all images to be submitted in a Joint Photographic Experts Group (JPEG) format.
2. All images should be stored at as high a resolution as possible. At no time should images be taken with less than four megapixels of spatial resolution unless this goes beyond the operational limits of the equipment.
3. Although some cameras can imprint date and time onto an image, this is not recommended. Date and time are embedded in JPEG headers by most cameras. In addition, imprinting an image can reduce the image quality and overall value.

II. Procedure for Downloading Images to PC Computer*

To download images, the following equipment is required: Olympus C-5050 digital camera with AC power cord adapter and USB cord, appropriate media card/s, and laptop or desktop PC computer with Microsoft XP or Windows compatible operating system.

(* Remote field sampling will require downloading images to a temporary folder on the laptop until that time when office transfer to network is possible).

1. Plug the AC power adapter into camera (preserves battery life).

2. Connect the camera to the computer with the USB cord.

3. Turn on the computer.

4. Turn on the camera, set to the camera's specified playback mode (e.g., Olympus C-5050: green forward arrow in box).

5. MS XP software will automatically open a window highlighting "Copy Pictures using MS Scanner and Camera Wizard" with a drive letter (e.g., E:). Click on **OK.**

6. "Welcome" pop-up window opens; select **Next.**

7. Thumbnails of images on the camera memory card are shown in the window below "Choose Pictures to Copy." Deselect any pictures you do not want to copy into computer folder by clicking on the image and un-checking the box. Select **Next.**

8. Type in a batch or "group name," all in lowercase: three letter **Site Code**, followed by underscore _, season (e.g., sp = spring or fa = fall), and two digit year (e.g., fkc_sp06).

9. Within the same window, choose destination folder for photos. Select **Next**.

10. Leave the "Delete photos… after copying them" box unchecked, as it is best to first check success of download before deleting photos.

11. When photos on the card need to be downloaded to another site folder, go back up to the "Choose Pictures to Copy" window and repeat steps after selecting appropriate image files to copy.

12. When done with digital downloads, click on **Finish**.

13. Before turning off the camera, check that all the image files transferred successfully and make a backup copy on CD or flashdrive or insert a new flashcard in the camera, keeping the original card as the backup.

14. If the camera memory card is going to be used again, delete images ONLY after backing up, by going to the set-up menu in the camera and selecting "erase all images."

15. Next, click the "Disconnect Hardware Safely" icon (on lower right toolbar). A prompt will be given for the external drive (e.g., E: or F:, varies by computer). When the "Safely remove USB Mass Storage Device" appears, click on that message prompt.

16. Message that "It is safe to disconnect" appears. Disconnect USB cord from computer and remember to turn OFF the camera.

III. Procedure for Naming Digitized Photoplot Images

The naming standards described here are adapted from Jack Engle's Photo Label Standards (updated 4/01/05) and are for photoplot file names only. Digital image file names have been standardized and are meant to conform to MARINe naming convention.

The rationale for the photoplot file name standard includes the following:

1. Photo file name must be easy to understand and implement and compatible with typical database style.

2. Photo file names should not use spaces or special characters. The underscore is OK as a separator.

3. For simplicity and reducing possibility of errors, photo file names should include only lowercase letters.

4. Even though a photo database can organize files based on keywords, etc., it is best if file names are descriptive and display in a logical order. However, not all information needs to be included in the file name (directories can be used to separate some broad categories) and the file name should not be lengthy (<20 characters preferred).

There are six main types of information that have been incorporated into MARINe photoplot file names. This hierarchy (in order from general to specific) is as follows:

1. **Site**: We will use standardized codes (lowercase) to conform with the database (Table 6).
2. **Target Species**: We will use the first three letters (lowercase) of the target species plot names in the database (Table 7). Using fewer than three letters could lead to ambiguities, while more letters unnecessarily lengthens the file name.
3. **Plot Number**: Plot identifiers should conform to consecutive #'s starting with "1" if possible (e.g., 1, 2, 3, 4, 5 ...).
4. **Date (Season/Year)**: Most of the core MARINe sampling takes place semi-annually (fall/winter and spring), though some northern sites are sampled annually (summer). Due to the nature of our sampling schedules (including limited number of adequate low tide periods, site access limitations, and weather delays), we have defined three sampling seasons (no winter), each four months long, as follows: fall = October-January; spring = February-May; and summer = June-September. This does not quite match the calendar year; thus, a sample in January 2005 would be listed as a Fall 2004 sample. Sites sampled in the winter months (i.e., December-January) are often referred to as fall/winter sampling periods but are entered as fall. Seasons will be abbreviated as lowercase two-letter codes (fall = fa, spring = sp, summer = su) and years will be abbreviated as the final

two digits (e.g., 1997 = 97, 2004 = 04). Using these codes means the file names as listed in alphanumeric order will group all fall photos, followed by all spring photos, and then all summer photos. Also, years in the new century (2000s) will sort out before the 1900s. This partial breakdown of chronological order was not considered significant enough to change to lengthier and less intuitive file names since the eventual implementation of a photo database will allow all kinds of sorts, including chronological.

5. **Photo Replicate:** For each photoplot sampling, there will be at least two photos to store: 1) the photo used for scoring and 2) that same photo overlain with the grid of 100 dots). In addition, there may be one to two (or more) other photos, often representing different exposures (e.g., one more overexposed and one more underexposed). (Note: we should not label and organize photos that we are unlikely to use, such as duplicate exposures or poor quality extra photos.) To differentiate the various photos for a given plot, we will add a single lowercase letter after the year in the file name as follows:
   "a" = scored photo (no dot grid).
   "b," "c," "d," "e," or "f" = additional photos taken (e.g., different exposures).
   "g" = scored photo overlain with dot grid.

Based on the above criteria, the **MARINe photoplot digital photo name standard** shall be:
"site" "_" "target species" "plot #" "_" "season" "year" "replicate"

Photoplot File Name Examples:
psn_maz2_fa04b.jpg = Pt Sierra Nevada, Mazzaella Plot #2, fall 2004, Replicate "b" (different exposure)

fkc_myt5_su05a.jpg = False Klamath Cove, Mussel Plot #5, summer 2005, Replicate "a" (scored photo)

IV. Procedure for Naming Other Digitized Images

For naming special photos, including reference overview and panoramic photos or other photos of interest, a systematic file naming convention will also be followed.

1. **Panoramic (Pan) Photos** are a series of pictures that document the site. It is VERY important that these be taken in approximately the same way/place every year. To name a pan, one should know from where the series was taken. Pan photos are usually part of a sequential pan of the reef and will be taken from reference points. Label the reference point as you would a plot number (e.g., r1). When possible, the first of the series should be taken facing north and then rotating clockwise. The standard should look like this:
   "site" "_" pan "_" "point where taken" "_" "numerical order in the series (e.g., 2of4)" "_" "season year"
   Example: **fkc_pan_r1_7of10_fa97**

2. **Overview Photos** show general topography or detail of the site but are not in a series of photos (like pans). These show areas of interest that are taken year after year. For naming, follow similar procedures as photoplot naming with the following exceptions:

instead of target species, use "area" and instead of plot #, use a descriptive word or number. The descriptive word is something that will differentiate the photo from other area photos (e.g., mussel_bed). The standard should look like this:

"site" "_" area "_" "descriptive word/number" "_" "season year" "replicate"

3. **Species Photos:** These pictures are close-ups of a marine organism. They are typically used for species identification or documenting a sighting of an organism. The standard should look like this:
   "site" "_" species name (latin preferred, or common)" "_" "season year" "replicate"
   Example: srfr_s_purpuratus_fa06_b

4. **People Photos:** These are photos of people monitoring or in the field that do not fit into the area category. The standard should look like this:
   "site" "_" people "_" "descriptive word/number (if needed)" "_" "season year" "replicate"

V. General Considerations for Submitting and Archiving Digital Records

Digital camera photos should be copied regularly to CD or DVD for archiving purposes. In addition, all images should be cataloged and metadata added using image management software according to the information management plan for the park.

The Project Manager should review the pictures and metadata, remove any photographs of poor quality, and submit the photographs and metadata to the KLMN Data Manager following the procedures and timeline outlined in SOP#17: Project Deliverables (Mohren 2006).

Metadata

The KLMN requires complete metadata for each image. Metadata can be submitted to the Network Data Manager via a correctly formatted Excel spreadsheet (Table 8).

Project-related photographs require additional metadata including:

1. Photograph name.
2. Project name.
3. Detailed description of the photograph (include names of individuals, species that occur in the photograph, general location names, site/plot/transect name or number, etc.).
4. Date the photograph was obtained.
5. Sensitivity comments. (Is there a reason this photo can not be distributed to the public?)
6. Easting and northing UTM location (when applicable).
7. Datum (default to NAD 83 zone 10).
8. Photographer.
9. Keyword (provided by the Network).
10. Collection (defaults to "KLMN").
11. Publisher (defaults to NPS).
12. Resource type (defaults to "Image").
13. Rights (default to "Public Domain").

File Structure and Folder Name

Photos being managed at the Network will be stored in the Intertidal project folder (e.g., G:\Monitoring\ Intertidal_Monitoring \Intertidal_Images) located on the KLMN shared drive. It will be the responsibility of the Data Manager to store all project images in this folder and place a copy of the images in the KLMN photograph folder. The photograph folder is linked to the Master Photograph Library database (G:\Library\Klamath Network Photographs Library), which is used to distribute photographs to Network staff.

Photograph Folder: The "Photographs" folder will contain all photographs managed by the Network. Photographs will be divided into "Category" folders that resided in the "Photographs" folder. Each category folder is used to separate the photographs into logical groups (Figure 8).

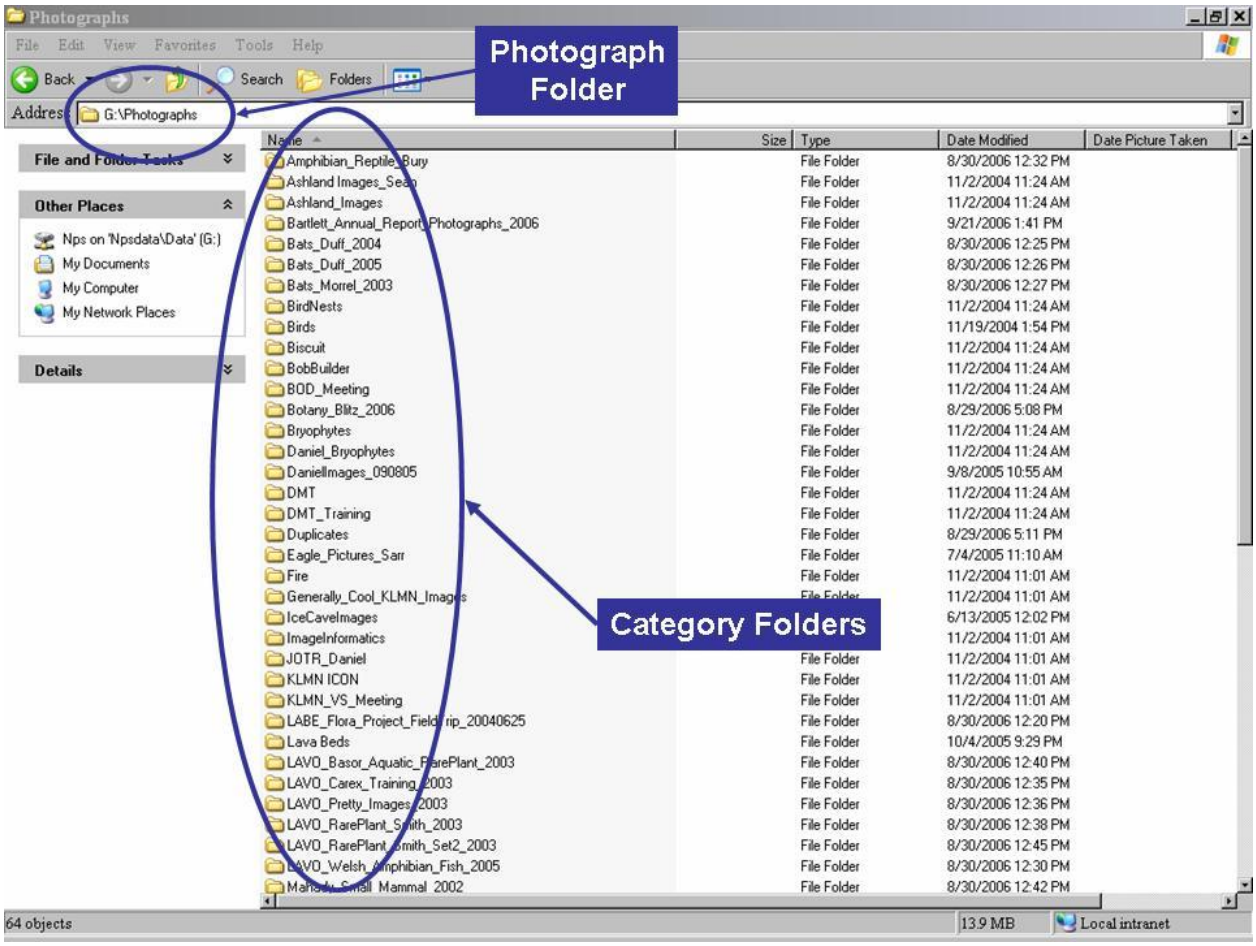

Figure 8. The Network Photograph folder with various category folders.

Category Folder: It is the responsibility of the individual downloading or saving an image to create and name the category folder. Naming conventions for category folders should meet the following standards.

1. Contains no spaces (separate with an underscore).

2. Has no special characters (e.g., &%@#*).
3. Includes a year in the format YYYYMMDD.
4. Describes the general theme of the group of photographs (e.g., Wildlife, Intertidal_2007, Panoramic_20070401, PhotoPlot_2007, Field Crew, etc.).
5. Includes the project name if applicable.

Project Folder: Each inventory or monitoring project has an associated standardized project folder located on the Klamath Network shared drive (Mohren 2007). Each project folder has an image folder entitled "*Project Name*_Images." All photographs and photograph metadata for a specific project will be stored in this folder. It is the responsibility of the Network Data Manager to make copies of these images and metadata and incorporate them into the "Photographs" folder that is linked to the Network's Master Photograph Library database.

VI. Related Documentation

Mohren, S. 2006. Digital photograph management guidelines. Klamath Network, National Park Service, Ashland, OR.

VII. Literature Cited

Mohren, S. R. 2007. Data management plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR--2007/012. National Park Service, Fort Collins, CO.

Table 6. Site Codes used in naming digital images for the three RNSP monitoring locations.

Site Code	Regular Monitoring Location
DMN	Damnation Creek
END	Enderts
FKC	False Klamath Cove

Table 7. Three letter codes for "Target Species" in Photoplot File Naming.

Target Species	Code		Target Species	Code
Chthamalus/Balanus	**cht**		Mytilus	**myt**
Endocladia	**end**		Semibalanus	**sem**
Mastocarpus	**mas**		Silvetia	**sil**
Phyllospadix (surfgrass)	**phy**		Lottia gigantea	**lot**

Table 8. Required metadata table for photographs.

*Park Code	*Network Code	Project	*Photo Name	*Date	*Photographer	*Description	UTM East	UTM North	Datum	*Category Folder	*Ext.	*Rights	Collection	Publisher	Resource Type
	KLMN								Nad 83 Zone 10		.jpg		KLMN	NPS	Image
	KLMN								Nad 83 Zone 10		.jpg		KLMN	NPS	Image
	KLMN								Nad 83 Zone 10		.jpg		KLMN	NPS	Image
	KLMN								Nad 83 Zone 10		.jpg		KLMN	NPS	Image

1) * Required fields.
2) Populated fields are populated with their default values.
3) Fields include:

Park Code – CRLA, LABE, LAVO, ORCA, REDW, WHIS
Network Code – KLMN
Project – Name of the project you are working on.
Photo Name – Name of the photograph. Do NOT include the extension.
Date – Date the photograph was taken in the format MM/DD/YYYY.
Description – A DETAILED description of the photograph. Include the name of the site if applicable.
UTM East and North – The UTM coordinates where the picture was taken, if applicable.
Datum – The datum and zone for the UTM coordinates. The default is Nad83 Zone 10.
Category Folder – The name of the folder where the picture is being stored.
Ext. – The extension. The KLMN requires photographs to be in jpeg format.
Right – Generally, rights are "Public."
Publisher – Owner of the photograph, usually NPS.
Resource Type – What is it (e.g. Image, PPT, Graphic)? This is usually Image.

SOP # 13: Metadata Guidelines

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) provides information for adding metadata documentation from the Redwood National and State Parks (RNSP) Rocky Intertidal Monitoring program. The MARINe database serves both as a key record and as a digital repository for all intertidal monitoring-related data, while metadata preserves valuable information (the "who, what, where, when, and how") associated with each record in a concise format. Metadata can be thought of as "data about data," a set of information that describes (in full) each data file (e.g., photograph) in the archive. This SOP is adapted from the Klamath Network (KLMN) Metadata Guidelines, written by KLMN Data Manager, Sean Mohren (Mohren 2007a). The guidelines are written to reflect current best practices used by the Klamath Inventory and Monitoring (I&M) Network, with standards developed for implementation (Mohren 2007b). While software and network applications will evolve, the intent and content of metadata should remain relatively consistent.

I. General Considerations

Metadata is meant, among other uses, to describe the content, quality, condition, and other characteristics of data files. Clear, complete, descriptive, and standardized metadata is important, as this improves the efficiency of finding data of interest. Cataloging accurate and complete metadata is a powerful technique to preserving critical information necessary for secondary data analysis and for cooperative data and image sharing.

Metadata collection is mandated for federal agencies by Executive Order 12906, signed in June 1994. Efforts to standardize metadata usage across NPS is expanding.

II. Introduction to Metadata

Data documentation is a critical step towards ensuring that datasets are usable for their intended purposes well into the future. This involves the development of metadata, which is defined as structured information about the content, quality, condition, and other characteristics of a dataset. In addition to spatial information, metadata includes information about data format, collection and analysis methods, time of collection, originator, access/use constraints, and distribution.

Metadata provides the means to catalog datasets within Intranet and Internet systems, making the associated datasets available to a broad range of potential users. While most frequently developed for geospatial data, metadata describing non-geospatial datasets is also needed (NCCN 2006a).

III. Timelines

It is the responsibility of the Project Manager, working with the Data Manager, to define timelines for metadata delivery during the planning phase of a project. If no timelines are defined, then it is the Project Manager's duty to submit metadata or metadata products (e.g., Metadata Interview Form) to the Klamath Network Data Manager in the proper format, no less than one month prior to the start of a new field season.

IV. Responsibilities and Standards

Metadata is an important piece of documentation that helps guarantee the long-term usability of data. The degree of documentation will vary depending on the product, but a few standards will always hold true.

1. Data collected through I&M funded projects will meet FGDC, NBII, and National Park Service (NPS) standards before being made available to the public.
2. Project Managers will be expected to submit a data dictionary and Metadata Interview Form prior to the start of the first field season.
3. Project Managers will be expected to review and revise the data dictionary and Metadata Interview Form at the end of each field season and report changes following the timeline listed in SOP #17: Project Deliverables.
4. It is the responsibility of the Data Manager to develop the official metadata based on the data dictionary and Metadata Interview Form provided by the Project Manager.
5. It is the Data Manager's responsibility to parse and transfer metadata to the NPS Data Store, if applicable.
6. The Data Manager will work with the Project Manager and park staff to determine the sensitivity level of any data.

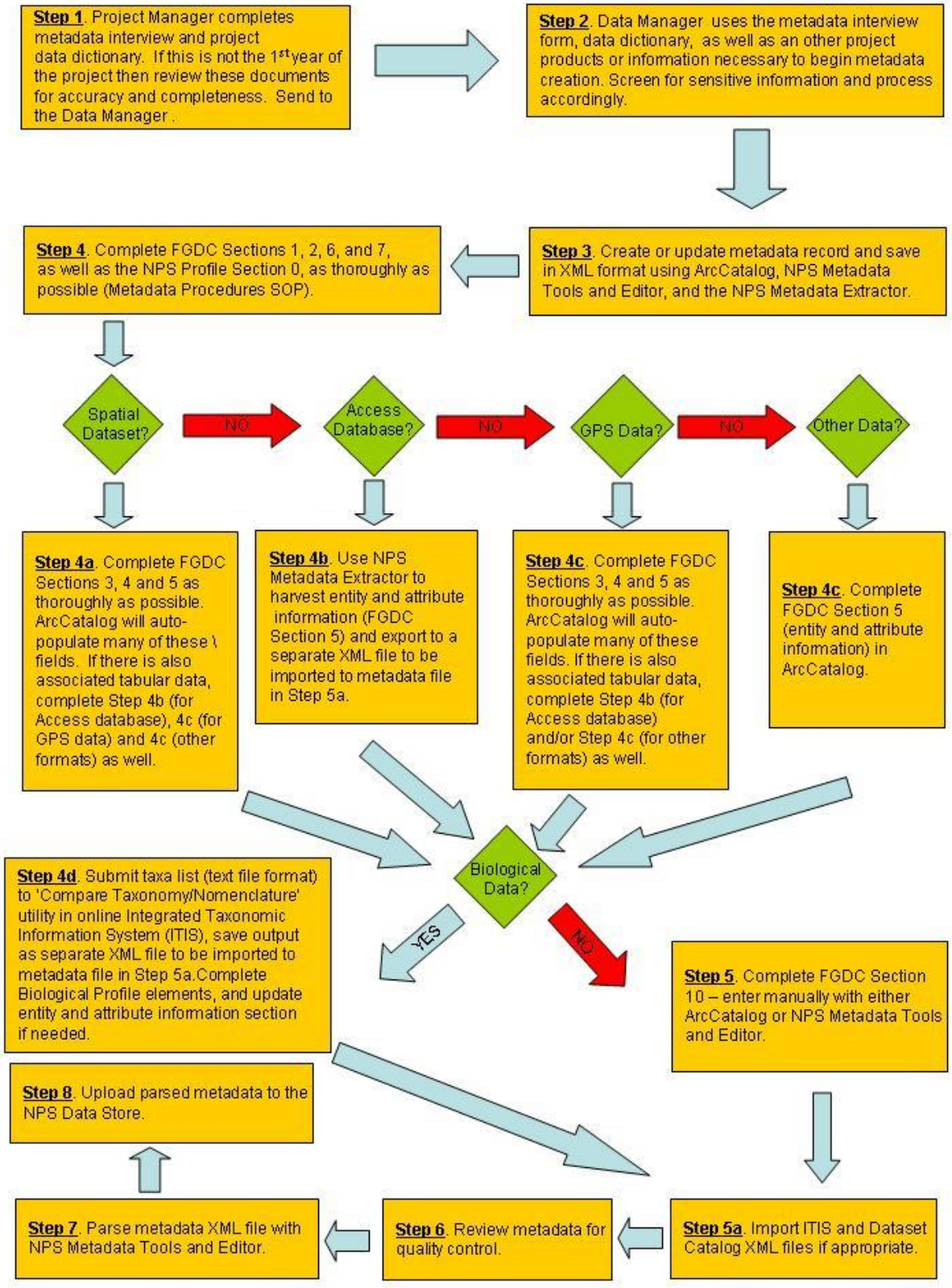

Figure 9. The following diagram shows the general workflow for metadata creation.

V. Steps for Metadata Creation

Step 1: Metadata Interview Form and Information Gathering

A. The Project Manager should obtain and complete the KLMN Metadata Interview Form at project onset. This facilitates compiling the information required to create compliant metadata.
    1. The KLMN Metadata Interview Form is posted on the KLMN Internet and Intranet web pages. In addition, the form can be obtained by contacting the Network Data Manager.
    2. Best attempts should be made to populate the Metadata Interview Form as completely as possible prior to starting field work. However, it is recognized that changes to the form will occur throughout the project.

B. A data dictionary must be created to provide information to help the Data Manager create or update the official metadata and, in some cases, the project database. The data dictionary should include:
    1. The name and purpose of each table, shapefile, coverage, or feature class.
    2. A list of attribute names, type, size, and description by table.
    3. If the database was not designed by the Klamath Network, it is the responsibility of the Project Manager to provide the Data Manager with the data dictionary.

C. If a taxa list other than the current ITIS certified taxa list was used, the Project Manager will need to provide that list at the end of each field season. Taxa lists should include:
    1. Taxon group (Bird, Mammal, Reptile, Invertebrate, etc.).
    2. Scientific name.
    3. Common name.
    4. Any special code that defines a species.

D. The Project Manager should send a copy of any additional information that might be valuable for the development of metadata.

Step 2: Sensitivity Review

Sensitive data (species locations, site locations, etc) may not be subject for release to the public.

A. The current version of the NPS Data Store does not screen for sensitive information. Therefore, any data with a sensitive status will not be posted on the Data Store.

B. The Network Data Manager will be responsible for posting data as sensitive. Status of the data will be based on comments provided by the Project Manager under the "Sensitivity" question on the Metadata Interview Form. In addition, the KLMN will consult with park staff if the sensitivity status of any data is questionable.

Step 3: Metadata Software Selection

A. The Klamath Network will utilize ArcCatalog, NPS Metadata Tools and Editor, and the Database Metadata Extractor to create metadata for all projects.
    1. ArcCatalog automatically harvests spatial organization and reference information, as well as entity and attribute information for GIS datasets.
    2. The NPS Metadata Tools and Editor is provided as a stand alone program or as an extension for ArcCatalog and is available at:

http://science.nature.nps.gov/nrdata/tools/

i. It can be used for metadata creation and editing.
ii. You can use this tool to import, export, and parse metadata
iii. You cannot harvest entity and attribute information. However, this is an anticipated feature for the next version.

3. The NPS Database Metadata Extractor is a custom software application for authoring, editing, and managing NPS metadata. The metadata extractor operates either as an extension to ArcCatalog versions 8.3/9.x or as a stand alone desktop application. Eventually this tool will be incorporated into the NPS Metadata Tools and Editor. Features of this tool include:
    i. Automatically harvests entity (table) and attribute (field) metadata from MS Access databases, including domains.
    ii. Allows the user to edit and review the harvested metadata and make batch edits.
    iii. Allows the user to export metadata to a FGDC-compliant XML file.
    iv. Exported XML can be used in the Metadata Tools and Editor either by opening it to start a new metadata record or by updating it with the template to fill in FGDC Section 5 of an existing metadata record.

Step 4: Additional Requirements

A. Along with the required metadata, the Klamath Network requires the following information be included in the metadata document:
    1. The name and agreement code for the project. These references can be entered in the Related Key element in the Program Information Section (NPS Section 0) on the NPS Profile.
    2. References to all products (GIS, GPS, Databases, Reports) generated by the projects. These references can be entered in the repeatable Cross Reference element of the Identification Information Section.
    3. Standard NPS liability language in the Distribution Liability metadata element of the Distribution Information (FGDC Section 6).
        i. This can be found at: http://www.nps.gov/gis/liability.htm.

Step 5: Biological Data Profile

If a dataset includes biological information, the Biological Data Profile provides a set of extended metadata elements to document the species observed, taxonomic information, methods, and analytical tools.

A. The most direct, and KLMN preferred, means to populating the Biological Data Profile metadata elements are outlined in Biological Profile (National Biological Information Infrastructure - NBII) Metadata Guide (NPS Data Store 2005a).
    i. This approach primarily utilizes the NPS Metadata Tools and Editor and may also require the entity and attribute harvesting capability of NPS Database Metadata Extractor for Access datasets.

B. The following two guidance documents describe alternative approaches to completing the Biological Data Profile for a metadata record. Note that the first requires the use

of additional metadata creation software (Spatial Metadata Management System, or SMMS):

i. Metadata Tools Used in the Creation of the FGDC Biological Data Profile (Callahan and Devine 2004).

ii. National Biological Information Infrastructure (NBII) Metadata Steps (McGuire 2004).

Step 6: Metadata Review

Review metadata for quality control (QC) prior to posting to NPS Data Store. A useful QC Checklist is available for download on the NPS Intermountain Region GIS website: http://imgis.nps.gov/tips_templates.html.

Step 7: Metadata Parsing and Exporting to XML Format

The NPS Data Store requires that metadata records be parsed into FGDC-structured metadata and then exported to XML format.

A. If using ArcCatalog, these steps can both be done directly with the NPS Metadata Tools and Editor. See Parsing Metadata with the NPS Metadata Tools and Editor (NPS Data Store 2005b) for more information.

B. If using another application, export the metadata first to ASCII text format and then parse with Metadata Parser (MP). MP can simultaneously output an XML format metadata file as well.

i. MP must be customized to handle NPS, Biological Data, or ESRI Profile metadata elements. For specifics, refer to:

a. The README.txt file included in the zipped NPS Metadata Profile configuration files available from the NR-GIS Metadata and Data Store website at: http://science.nature.nps.gov/nrdata/docs/metahelp/metahelp.cfm.

b. Parsing Metadata with the NPS Metadata Tools and Editor (NPS Data Store 2005b)

Step 8: Metadata Posting

Post the metadata to the NPS Data Store.

A. Authorized NPS staff may request upload and edit access to the NPS Data Store through the NPS Natural Resource Universal Web Login (UWL) available at: https://science1.nature.nps.gov/nrdata/. This is also the portal for uploading data.

B. More information about metadata upload format requirements is available at: http://science.nature.nps.gov/nrdata/docs/metahelp/metainfo.cfm and in Metadata and Data Uploading Guidance (NPS Data Store 2005c).

Step 9: Editing/Updating Metadata Already Posted to NPS Data Store

As of Version 1, the NPS Data Store application allows online editing of NPS Theme Category and ISO Theme Keyword information and the deletion of single metadata records and/or datasets only (help documentation: http://science.nature.nps.gov/nrdata/docs/metahelp/edithelp.cfm).

A. For metadata records simply needing edits to NPS Theme Category or ISO Theme Keyword elements, refer to Editing Category Information (NPS Data Store 2005d).

B. If a metadata records posted to the NPS Data Store contain errors or require edits to other elements, you should contact the Klamath Network Data Manager. Erroneous metadata will need to be deleted from the NPS Data Store, edited, then reposted. Refer to Deleting Single Records (NPS Data Store 2005e).

i. The user should first download the metadata record (save in XML format) to the local system, then edit as needed in a text editor or metadata software program.

ii. The edited metadata record can then be resubmitted to the NPS Data Store.

iii. If the dataset documented by the metadata record requires no edits, it will not need to be reposted. Simply ascertain that the metadata file still specifies the correct pathway to the dataset on the NPS Data Store before resubmitting the metadata file.

VI. Literature Cited

Callahan, K., and H. Devine. 2004 (draft). Metadata tools used in the creation of the FGDC biological data profile. National Park Service, Northeast Region. Online. (http://science.nature.nps.gov/im/datamgmt/docs/SOP_BioDataProfileTools_v1.doc). Accessed 30 January 2008.

Executive Order No. 12906 (Coordinating geographic data acquisition and access: The national spatial data infrastructure). April 11, 1995, 59 FR 17671.

McGuire, S. 2004. National Biological Information Infrastructure (NBII) metadata steps. National Park Service, Midwest Region. Online. (http://www.nature.nps.gov/im/units/mwr/gis/download/BiologicalProfileGuide.pdf). Accessed 30 January 2008.

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NR-GIS Data Store. 2005b. Parsing metadata with the NPS Metadata Tools and Editor. National Park Service, Natural Resource and GIS Programs. Online. (http://science.nature.nps.gov/nrdata/docs/metahelp/NR-GISMetadataParsingGuidance.pdf). Accessed 30 January 2008.

NR-GIS Data Store. 2005c. Metadata and data uploading guidance. National Park Service, Natural Resource and GIS Programs. Online. (http://science.nature.nps.gov/nrdata/docs/metahelp/NR-GISMetadataDataUploadGuidance.pdf). Accessed 30 January 2008.

NR-GIS Data Store. 2005d. Editing category information. National Park Service, Natural Resource and GIS Programs. Online. (http://science.nature.nps.gov/nrdata/docs/metahelp/NR-GISDataStoreEditCategory.pdf). Accessed 30 January 2008.

NR-GIS Data Store. 2005e. Deleting single records. National Park Service, Natural Resource and GIS Programs. Online. (http://science.nature.nps.gov/nrdata/docs/metahelp/NR-GISDataStoreDeleting.pdf). Accessed 30 January 2008.

Electronic Metadata Interview

[**Note: Please make your responses directly within this word document in "Red" type**.]

1. Have you already prepared metadata for this dataset?
    a. If yes, please send a copy of the document or reference to where it can be found and skip to item **18**.
2. What is the title of the dataset?

3. Who are the originator(s)/owner of the dataset? (Include address, and telephone number)
    a. If someone else should answer question about the data, please list the name, address, and telephone number.

    b. Are there other organizations or individuals who should get credit for support, funding, or data collection and analysis?

4. Does the dataset contain any sensitive information that should not be released to the public? NPS?
    a. Explain why the data should not be released to the public.

    b. Explain why the data should not be released to non-park NPS staff.

5. Is the dataset published or part of a larger publication?
    a. If so, what is the reference?

6. Include a brief (no more that a few sentences) description of the dataset.

7. Why were the data collected in the first place?

8. What is the time period represented by the dataset?

9. Where the data developed primarily through:
    a. Field visits.
    b. Remote instrumentation (i.e., Temperature recorders, etc.).
    c. Existing data sources.

10. What is the status of the data you are documenting? – *complete, in progress, planned*
    a. Will the data set be updated? If so, how frequently?

11. Where were the data collected? Include description and coordinates, if known.

12. List some keywords to help search for this dataset.
    a. Thematic, Place, Temporal, Strata, Taxonomy.

    b. If a controlled vocabulary was used, what is the reference?

13. List any related datasets that could be documented for cross-reference.

14. The FGDC Biological Profile included the means to document tabular datasets, taxonomy, field methods, and the use of analytical tools or models.
    a. Was your dataset developed using a model or other analytical tool?

        i. If so, what is the reference?

        ii. If the model or tool is available include a contact and/or URL.

    b. Does the dataset contain biological information? If no, skip to item **15**.
        i. What species or communities were examined?

        ii. Did you use a taxonomic authority or field guide for identification? If so, what is the reference?

        iii. Briefly summarize your field methods (cut & paste from other documents!).
            1. If you used existing protocols or methods, list the references.

        iii. If you use a different taxonomic hierarchy then what is available in ITIS then you need to supply the taxonomic hierarchy for all species within the dataset.

15. Is your dataset archived in a databank or data catalog? If yes, please include a reference to the documentation and skip to item 16. If No:
    a. What Measures did you take to make certain that your dataset was as nearly correct as possible?

    b. Were there any things that you excluded from your data collection i.e., stems less than a certain diameter or streams without surface flow.

    c. What is the form of your dataset? - *spreadsheet, ASCII file, gis layer, database, other*.

    d. What is the filename for your dataset?
        i. For each file or table, list the fields in the dataset and for each field list:

        ii. The definition of the field

        iii. If the data are coded (Enumerated Domain), list the codes and the definitions.

        iv. If the codes come from a published code set (Codeset Domain), list the reference.

v. If the data are measured (Range Domain), list the units and the minimum and maximum allowable values ("no limit' is acceptable).

vi. Otherwise, the domain is unrepresentable. Include a brief description of what is in the field.

16. Is this a GIS dataset? If no, skip to item 17.
    a. Include a path to where the data can be accessed over the network or send a copy of the ArcInfo export file, an ArcView shapefile, or an ArcCatalog exported metadata file (txt or xml).
        i. Include projection parameters, if necessary.

    b. List any source datasets you used. For each source list:
        i. Source name, originator and publication date.

        ii. Source time period and scale.

        iii. Source presentation form and media type.

        iv. Contribution of source to your analysis.

    c. List the processing steps you used to create your dataset, including the approximate date of processing.

17. Is the dataset available for distribution? If no, go to 18.
    a. Are there legal restrictions on who may use the data?

    b. Do you have any advice for potential users of the dataset?

    c. What are your distribution instructions?

18. You are done. Send this completed document with the relevant responses to this interview to your metadata coordinator (Sean Mohren, Klamath Network Data Manager. Sean_Mohren@nps.gov, 541-552-8576).

SOP # 14: Data Entry and Management including Uploading to MARINe Database

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) provides an overview of data management procedures, including entering biological data into the Multi-Agency Rocky Intertidal Network (MARINe) database and data certification. This SOP also includes instructions on how and when to upload data to the MARINe database. The MARINe database was prepared by Bruce Bealer and Larry Cooper at Southern California Coastal Water Research Project (Bealer and Cooper 2003). The database instructions manual is included in full as supplementary material (Appendix C).

I. MARINe Database Overview

The MARINe Data Management System (MDMS) provides a uniform data acquisition, data analysis, and information storage and retrieval system for the Multi-Agency Rocky Intertidal Network. Members of MARINe, including RNSP, survey intertidal sites twice a year, once in spring/summer and again in fall/winter, during the daylight low tides. Each monitoring group records information about the species in the intertidal environment. Bi-annual sampling provides the basic design for the MARINe Data Management System.

Database Design

The MARINe database is an event driven database, designed for the semi-annual MARINe surveys. Data collected during the surveys are recorded in one of three "results" tables. The correct results table to use is based on the method of observation used in obtaining the results. These sets of results are recorded for each site in the MARINe system.

Basic Structure

Each site is a geographical location defined by its longitude and latitude. Within each site, collected data are categorized by one of three method types: photoplots, transects, or count and size. Within each method, plots or transects are grouped by target species. There can be one or more plots associated with a target species. It is this combination of site, plot type, target species, and individual plot ID which provides the uniqueness of each species recorded.

The site-specific data are combined with seasonal environmental sampling event data to provide a unique survey result record. The environmental event data must be entered prior to recording seasonal data.

II. Using the Database

It is the responsibility of the Project Lead to enter all data into the MARINe database. Each season, a new version of the database will be downloaded from the MARINe internal web site and stored on the Project Lead's main computer. A backup will be stored on the University of California at Santa Cruz's computer network in a restricted folder. Copies of the database should not exist on multiple computers. It is highly recommended to directly work in the MARINe database only when doing seasonal maintenance or adding survey results. All analysis and investigation should be through another Access database and linked tables. The simple activity of adding a new table could cause automated functions to fail. Refer to the complete MARINe database user's manual before attempting to enter or manipulate data (Appendix C).

The following are general guidelines to keep in mind:

1. Data entry should occur as soon after data collection as possible, so that field crews keep current with data entry tasks and catch any errors or problems as close to the time of data collection as possible.
2. The working database will first be copied onto one workstation hard drive. All entry for a given field season will occur into this copy, preferably by a single user.
3. Each data entry form is patterned after the layout of the field form and has built-in quality assurance components such as drop down lists and validation rules to test for missing data or illogical combinations.
4. As data are being entered, the person entering the data should visually review each data form to make sure that the data on screen match the field forms. This should be done for each record, prior to moving to the next form for data entry.
5. Backing up the entered data should occur frequently with caution made to name the backed up database something that will not be confused with the working database copy.
6. When an entire season of data has been entered and checked for errors, the data are submitted to the main MARINe database.

Starting a New Season

Data for a season must be added in a specific sequence because most information depends upon supporting data having been previously entered. The basic sequence for entering data for a new season is to enter maintenance data, then event data, and finally results data. The items below indicate which activities to perform and their sequence.

Main Menu

The Main Menu (Figure 10) is the first screen presented after the application is launched. This menu provides access to all the database functions.

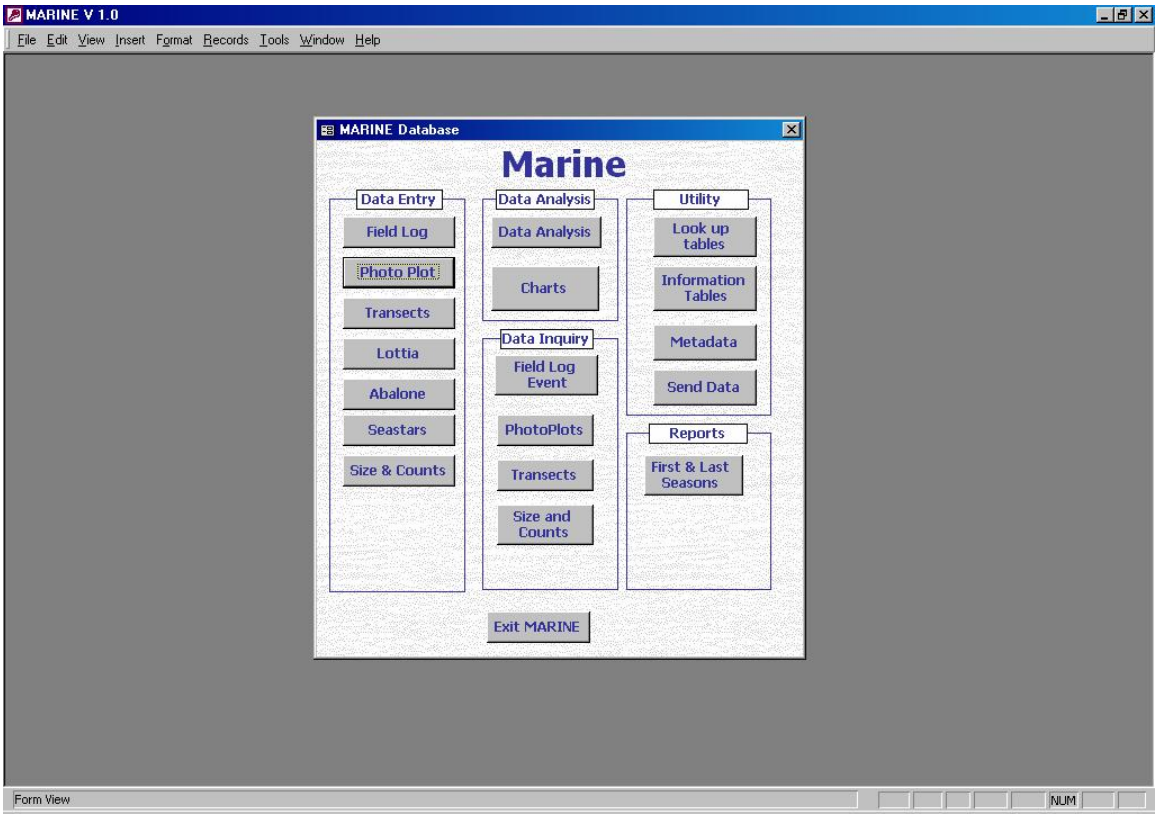

Figure 10. MARINe database main menu.

Data Entry Sequence

Tables must be loaded in a specific sequence because data in one table are dependent on data in a related table. Tables should be loaded in the following order (Appendix C has detailed instruction):

1. **Maintenance data:** Enter any changes or additions to maintenance tables first. Maintenance data are recorded in lookup tables. Lookup table names start with luListXX_LookupName. The season and personnel tables are examples of maintenance tables. *Add new seasons and personnel before entering any results data*.
2. **Information tables:** These tables contain data specific to MARINE that is not the result of seasonal surveying activity; therefore, they will rarely need to be updated. The site table is an example of an information table.
3. **Results table:** These tables record the actual results data of a field site survey. The field log event table is an example of a results table. It must be populated before the other results tables.

Survey Data Entry

These results tables record the survey data of the intertidal field monitoring. The following is a list of the results tables with a brief description of each. Refer to the MARINe User's Manual (Appendix C) for complete data entry instruction.

1. **Field Log Event Data Entry Form:** The Field Log Event Data Entry form is actually two forms: the Field Log form (Figure 11) and Site-wide Species Conditions form (Figure 12). For field methods, refer to SOP #4: Completing Field Logs and Assessing Site-wide Species Conditions. When you complete the Field Log form, click the "Continue" button and the Site-wide Conditions form will open. Both pages of the form must be completed at the same time.

These forms must be loaded before the other results tables. The survey dates entered here appear in drop down boxes on the other forms.

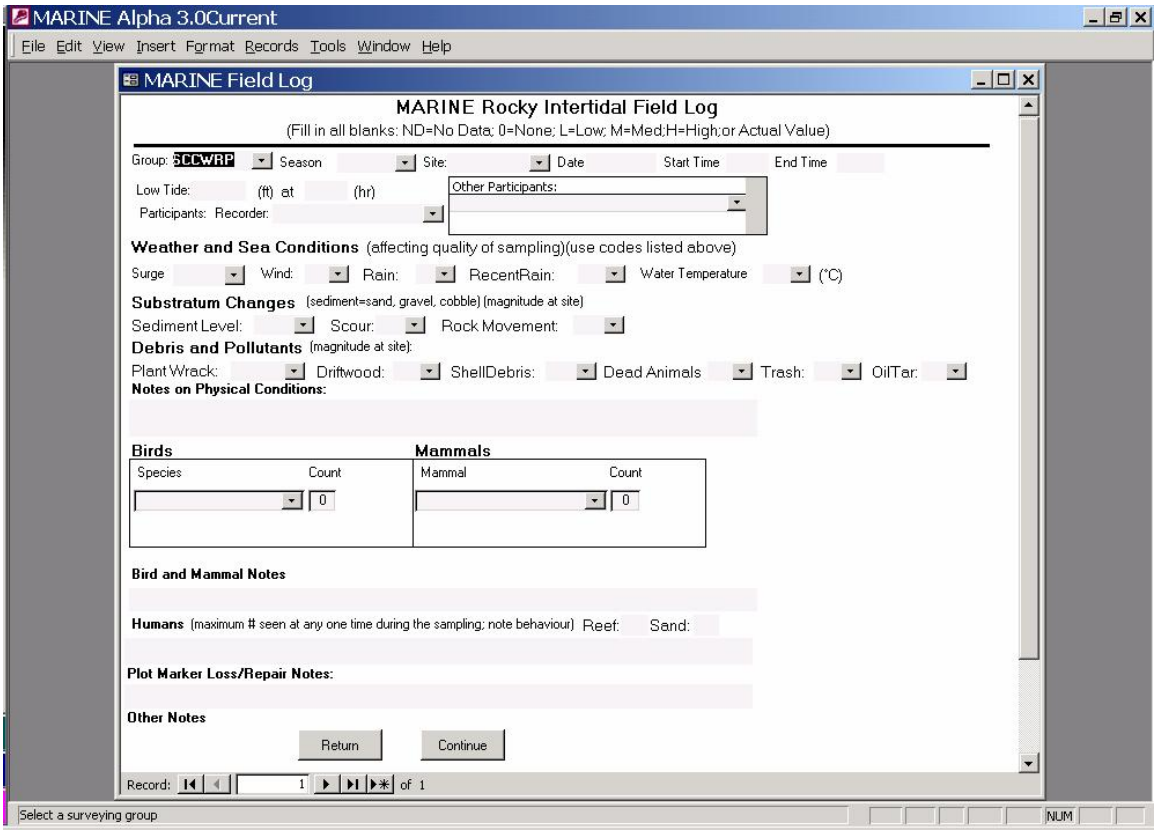

Figure 11. MARINe Rocky Intertidal Field Log form

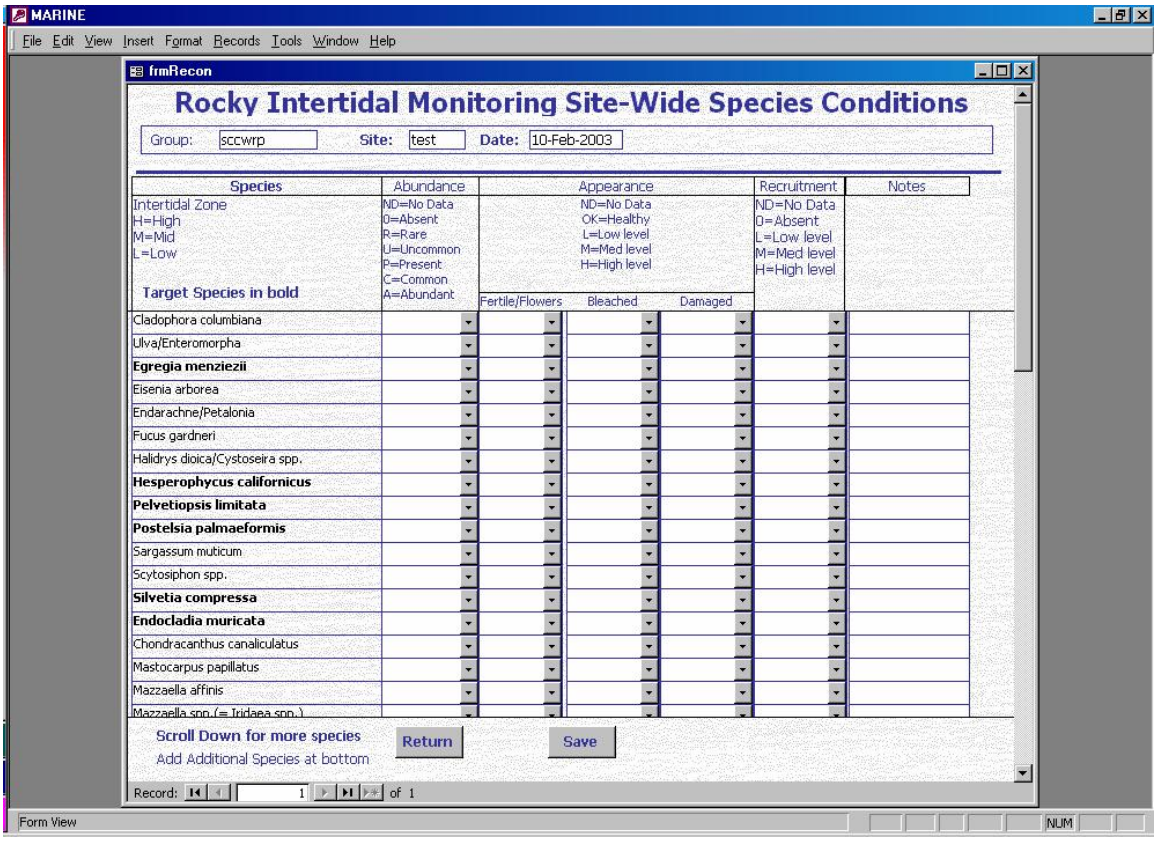

Figure 12. MARINe Rocky Intertidal Site-wide Species Conditions form.

2. **Photoplot Data Entry Form:** This screen (Figure 13) is for entering summarized photoplot data (SOPs #5-7) (i.e., data that have been converted to percent cover for selected target species plots). The photoplot data entry form is designed to enter results one plot at a time.

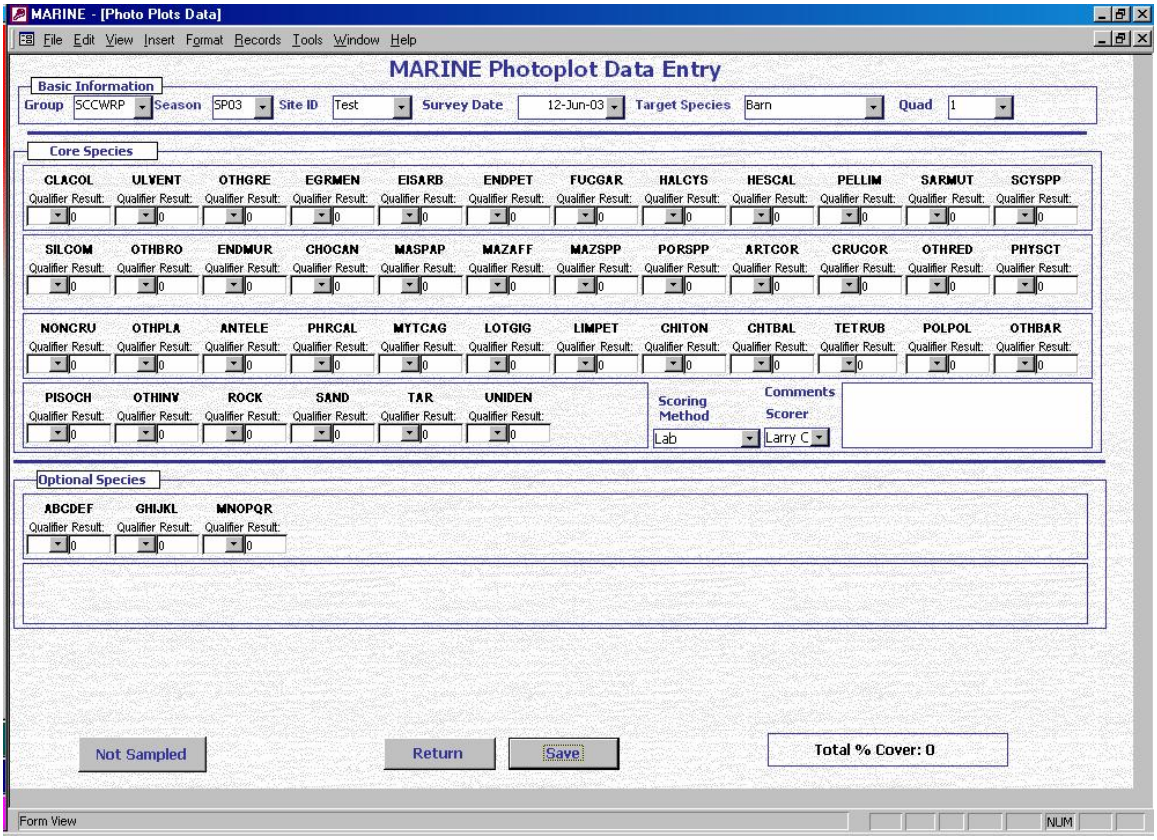

Figure 13. Photoplot data entry form.

Transects Data Entry Form: This screen (Figure 14) is for entering summarized transect data (SOP #10: Surfgrass Monitoring). That is, data that have been converted to percent encountered for selected target species transects, namely surfgrasses (*Phyllospadix scouleri/torreyi*).

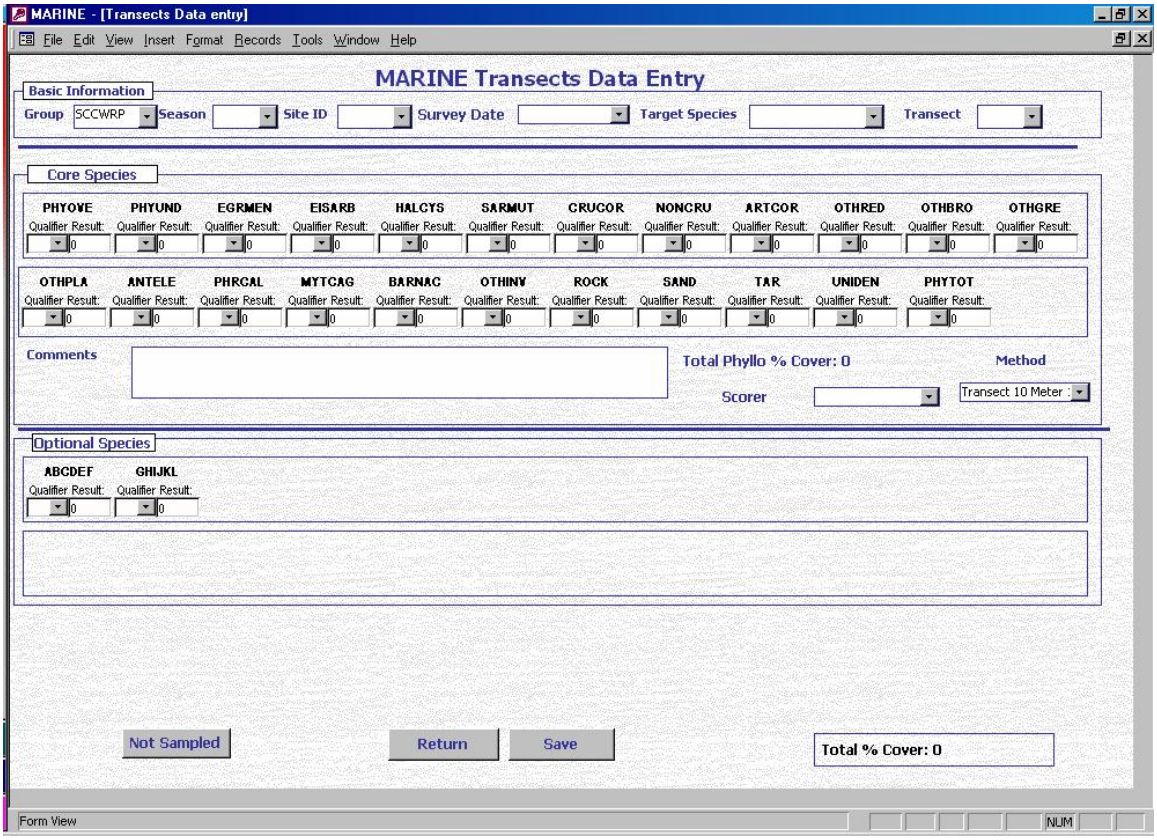

Figure 14. Transects data entry form.

3. **Sea Stars Data Entry Form:** This form (Figure 15) is for entering summarized size and count information that has been totaled for each size class of ochre sea star (*Pisaster ochraceus*) (SOP #9: Sea Star Monitoring).

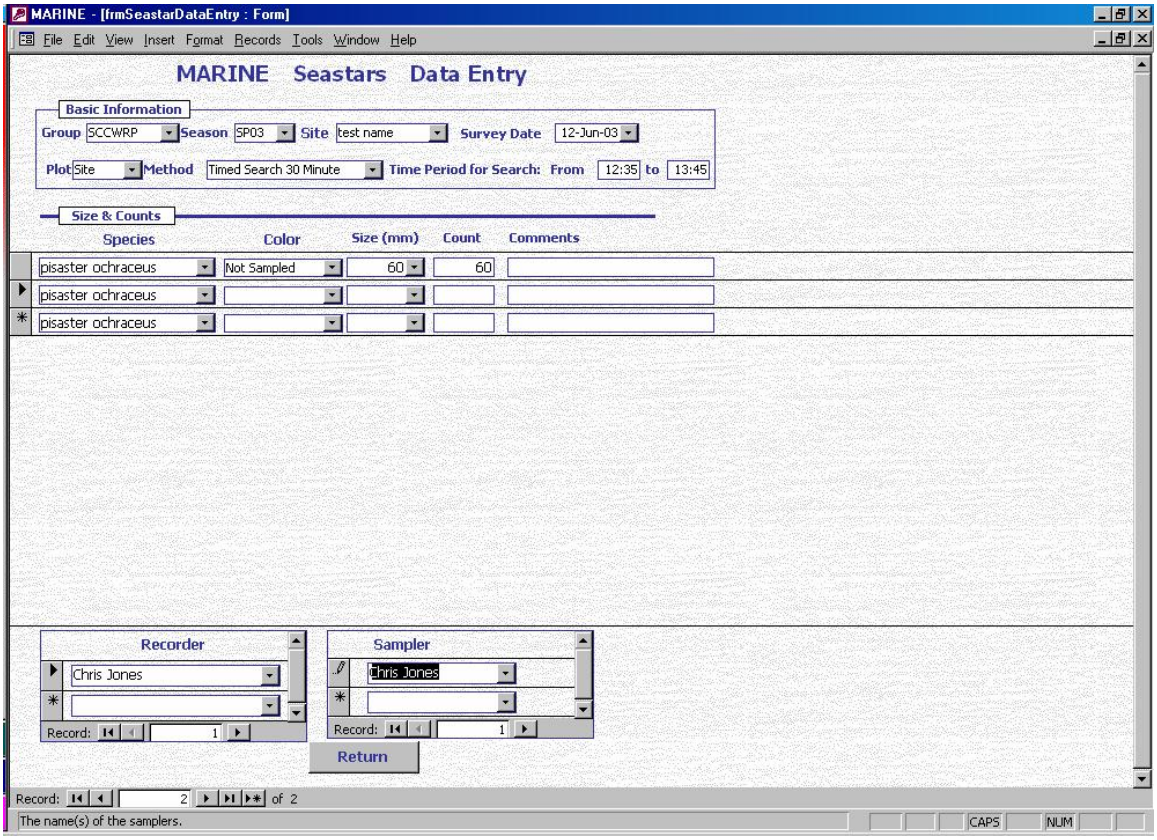

Figure 15. Sea stars data entry form.

III. Sending Data to SCCWRP

The main MARINe database is maintained by the Southern California Coastal Water Research Project (SCCWRP). After each field season's data are entered into a copy of the database and thoroughly checked for any obvious mistakes, this copy is sent to SCCWRP to be included in the updated version of the main database. The Project Lead will be responsible for all database tasks, including entering, checking, and sending off data.

The Send Data button is used to select data that have not been sent to SCCWRP, create an Access database to store it in, and, if an email system is available, send an email to SCCWRP with the database as an attachment. If an email system cannot be found, the user must attach the Access database to an email and send it to SCCWRP at larryc@sccwrp.org.

Database Update Schedule

Fall survey data (typically October-January) should be submitted to the main MARINe database at SCCWRP no later than **March 1** of the following year. Summer survey data (typically May-

August) should be submitted no later than **November 1** of the current year. This allows roughly three months for scoring slides and completing the data entry templates. Updated versions of the database will be released twice a year: by **April 1** and **August 1**. Table 9 summarizes this schedule.

Table 9. Summary of submission and release dates for the MARINe database, by survey season.

Survey Season	Data Submission Deadline	Database Update Released
Fall	March 1	April 1 or August 1
Summer	November 1	April 1 or August 1

IV. Completing Data Certification

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all deliverables except reports. The Project Lead is primarily responsible for completing the Klamath Network Data Certification form (Attachment L), which tracks the submission of project products to the Network. Forms can also be obtained by contacting the Network Data Manager or by going to the Klamath Network website. The Certification form should be submitted, along with all project products, prior to the start of a new field season. A new Certification form should be submitted each time a product is submitted. If multiple products are submitted at the same time, only one Certification form is needed for those products.

The Project Manager will summit a Data Certification form (Mohren 2007) to the Klamath Network to ensure:

1. The data are complete for the period of time indicated on the form.
2. The data have undergone the quality assurance checks indicated in the vital sign monitoring protocol.
3. Metadata for all datasets has been provided.
4. Project timelines are being followed and all products from the field season have been submitted.

Data Certification Form

A description of each field on the certification form is included below.

1) Certification date – The date the form was submitted to the Klamath Network.
2) Certified by – The name of the person certifying the products.
    a. Title – Position of the person certifying the products.
    b. Affiliation – Agency / Organization / University.
3) Project code – Each project will be given a code by the Klamath Network.
    a. Project title – Each project will be given an official title by the Klamath Network.
4) Ranges of dates for certified data – Include the month and year of the data collected for the products you are submitting.
5) Description of the data being certified – Give a brief description of each product that is being submitted.

6) Parks and details – List any parks that are represented by the products being submitted. Provide any details that might be necessary to understand the relationship between the products being submitted and the park represented.
7) Certification product and name – Put a checkmark next to each type of product you are submitting. Indicate the name of the file(s) next to the product. If the product is an image, indicate the name of the folder used to store the images.
8) Sensitive information – Indicate if the product can be released to the public. This does not mean the Klamath Network will release the product, but this information is necessary in case we have to, or chose to, release the product (e.g., FOIA request).
9) Data processing and quality assurance procedures – Describe what QA/QC steps were involved to ensure the accuracy and quality of the data. You only need to describe processes outlined in the protocol that were NOT followed, or processes that were not outlined in the protocol but were used for these products.
10) Who reviewed the product – Describe who reviewed the product for content, sensitivity, and quality. At a minimum, the Project Manager should be included in this step.
11) Results of the QA – Describe what steps were involved to resolve any issues that came up during the quality assurance reviews.

Literature Cited

Bealer, B., and L. Cooper. 2003. MARINe database user guide. Version 3.1. SouthernCalifornia Coastal Water Research Project, Westminster, CA.

Mohren, S. 2007. Data certification guidelines. National Park Service, Klamath Network, Ashland, OR.

Attachment L. KLMN Certification Form.

1) Certification date:_____

2) Certified by: _____
Title: _____
Affiliation: _____

3) Project code: _____
Project title: _____

4) Range of dates for certified data: _____

5) Description of data being certified: _____
6) List the parks covered in the certified data set, and provide any park-specific details about this certification.

Park	Details

7) This certification refers to data in accompanying files. Check all that apply, and indicate file names (folder name for images) to the right:

_____ Hardcopy Datasheet(s):_____
_____ PDF Datasheet(s): _____
_____ Database(s): _____
_____ Spreadsheet(s):_____
_____ Spatial data theme(s): _____
_____ GPS file(s): _____
_____ Geodatabase file(s): _____
_____ Photograph(s): _____
_____ Data Logger(s) files: _____
_____ Other (specify): _____
Certified data are already in the master version of a park, KLMN or NPS database. Please indicate the database system(s): _____

8) Is there any sensitive information in the certified data which may put resources at greater risk if released to the public (e.g., spotted owl nest sites, cave locations, rare plant locations)?
_____ No _____ Yes Details:
_____
_____

9) Was all data processing and quality assurance measures outlined in the protocol followed? Yes / No
If No, Explain_____
_____

10) Who reviewed the products? _____

11) Results and summary of quality assurance reviews, including details on steps taken to rectify problems encountered during data processing and quality reviews.

SOP # 15: Data Analysis and Report Writing

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) gives important guidelines for completing reports for the Rocky Intertidal Monitoring Program at Redwood National and State Parks. This SOP discusses annual reports and trend reports and includes procedures on when, where and to whom the reports should be electronically submitted.

I. General Considerations for Writing Reports

Annual reports are the responsibility of the Project Lead. The reports' main purpose is to archive the data and procedures for the year(s). Analysis and Synthesis or Trend reports are written every five years and are meant to be a multi-year summary showing data relevance. Trend reports will also be the responsibility of the Project Lead with assistance from the Data Analyst and Principal Investigator. Trend reports are subject to a thorough peer review process that includes park staff.

It is a recent objective of the National Park Service (NPS) Inventory and Monitoring (I&M) Program to streamline annual reporting; best efforts should be made to comply with new policies. Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Both reports should be completed using the Natural Resource Technical Report template. This template and documentation of the NPS publication standards are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.

II. Procedures for Annual Reporting

1. Complete the annual report in a totally digital format. The annual report will be published as a technical report for the park and therefore should follow the standard, accepted format for a national technical report. If the report has pages generated as Access reports, you will need to run the report while in Access and **save it with a .snp file extension**.

2. Files should follow the naming structure outlined in the Klamath Network File Naming Convention Guidelines (Mohren 2007). Standardized file names should adhere to the following guidelines (Figure 16):
    a. File name will be no less than ten characters in length.

b. File names must never contain special characters (*&@%$) or spaces. When separating names, use an underscore (e.g., use_underscore).
c. Dates will be in one of the following formats YYYYMMDD, YYYYMM, or YYYY. The most detailed date information should be used whenever possible. If the date of a file is unknown, refer to the date as "XXXX."
d. The date should correspond to the date the document or version of the document was created. Dates should be the last component in the naming convention.
e. The title should be the first portion of the file name, be in mixed case format, and as descriptive as possible (e.g., FileNaming_v1.00_200608).
f. The word "Final" should be included in the name of the final document, occurring before the version number and after the title.
g. If multiple versions of a file are created, a version number should be included in the file name following the title (SOP#16: Revising the Protocol).

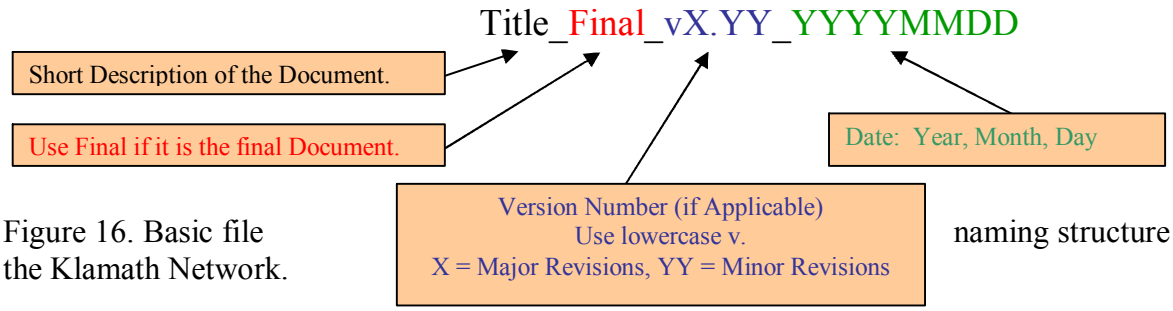

Figure 16. Basic file naming structure for the Klamath Network.

3. Collate document together, with appendices (use of templates posted on the NRPM web site is highly recommended), and submit draft manuscript and the NRPM Manuscript Submittal Form and Checklist via email to one of the NPS Key Officials listed on the NRPM web site.

4. The NPS Key Official determines whether or not additional peer review is necessary based on the manuscript content and the quality of the initial reviews, and if deemed appropriate, arranges for and oversees additional peer review. The NPS Key Official determines whether or not a management review is necessary, and if so, selects an appropriate reviewer who can verify consistency with NPS policy, clear and appropriate relation to NPS policy, and appropriate treatment to sensitive issues.

5. Once the Key Official is satisfied that reviewer comments have been adequately incorporated and the report meets the minimum standards for the series, the report is approved for publication in one of the series and the contributor obtains a report number as well as an NPS Technical Information Center (TIC) identification number following the guidance on the NRPM web site.

6. Once the report numbers are added, produce a portable document format (PDF) version of the publication and send it to the RNSP Project Manager. In addition, submit the PDF and all documents used to create the PDF (e.g., .xls, .doc, .jpeg, .ppt, .snp, etc.) to the Klamath Network (KLMN) Data Manager.

7. The KLMN Data Manager will be responsible for archiving and distributing the document following processes outlined in the KLMN Data Management Plan. Annual reports will be sent to the Resource Chiefs of each park, uploaded to the NPS Database NatureBib, and posted on the KLMN Internet and Intranet web sites. A record for the report will be created in NatureBib. Species listed in the annual report will be compared to park species lists in NPSpecies to ensure all species are included on the lists. Discrepancies between species in the report but not on the park species list will be discussed between project researchers, park staff, and the Klamath Network, with adjustments made if necessary.

III. Procedures for Trend Reporting

1. Complete a trend report every five years (or when analyses are warranted), again using a totally digital format. The trend report, like the annual report, will be published as a technical report for the park and therefore should follow a standard, accepted format for a national technical report. The use of templates posted on the NRPM web site is highly recommended.

2. The Project Lead is responsible for ensuring standard NPS font and graphic guidelines are followed and for checking report accuracy and completeness. If report pages are generated as Access reports, run the report while in Access and **save it with a .snp file extension**. This will assist when it comes times to save the entire report in PDF format.

3. The report is written at a general audience level and uses a graphic presentation of the data where possible. Since the data have already been tabularized and summarized in the annual report, trend reports should concentrate on important issues and changes observed since the monitoring program began.

4. Naming conventions for trend reports should follow a similar format to the annual report described above.

5. After an initial review by internal staff and incorporation of revisions/comments, submit trend report for review to the Project Manager, KLMN Coordinator and Data Manager, and any additional experts that could provide critical input to the report.
6. Once reviews are complete, follow steps 3-7 under the annual reporting section of this document.

IV. Components of Annual and Trend Reports

The general outline of the annual and trend reports should include:

1. A brief Narrative section describing the project along with the goals and objectives as well as any logistic problems that were encountered and providing suggestions for preventing or coping with similar problems in the future.

2. A Methods section detailing data collection procedures and analytical techniques; this may change little from year to year but should still be included as part of each year's report. The section should highlight any changes from previous methods.

3. A Results section that describes the content of the summary tables and figures (see data analysis in next section).

4. Graphs showing trends in the mean counts of the most common species detected.

5. A brief Discussion section that highlights and interprets any notable findings, such as detections of unexpected or invasive species, unexpectedly large changes in species abundance patterns (>50% change), or factors such as unusual oceanic conditions that might have affected results.

6. An Acknowledgements section thanking individuals and organizations who contributed to the field season or the report.

V. MARINe Data Analysis

To examine variation in the abundance of target species in space and time, summary statistics (mean and standard error of the mean) for all sites and sample periods are calculated and graphically plotted. Analyses of covariance (ANCOVA) procedures are used to assess seasonal and temporal patterns of abundance for each of the target species at each site (Miner et al. 2005). In the models, season is included as a categorical variable and time (sample) is included as the covariate. Comparisons of the community dynamics among the RNSP sites are used to track changes within the park and are also integrated within the broader sampling efforts of MARINe. This collaboration provides more power to evaluate local changes in the context of a broader system, which is able to consider large-scale changes in the environment such as geographic variation in climate.

Statistical analysis for the RNSP status and trend reports will follow a similar assessment to the trend reports completed for Cabrillo National Monument's rocky intertidal program (Becker 2006). Details of these analyses can be found in the Cabrillo National Monument Trend Report and are paraphrased as follows. The same number of fixed plots is established in each zone using a random, stratified experimental design appropriate to the highly patchy habitat (Miller and Ambrose 2000). Basic trends of percent cover, averaged by zone, are graphed for all key species for photoplots (e.g., barnacles (*Chthamulus, Balanus*, etc.), mussels (*Mytilis spp.*), rockweed species (e.g., *Silvetia compressa*), and line transects for surfgrass (*Phyllospadix spp.*). In order to minimize variability, photoplot target types are not pooled when analyzed. For example, the percent cover of mussels was considered only in mussel plots. Line transect target types are pooled, since there are only two transects of each target type in each zone. Photoplots and line transects are all "fixed," or measured in the same location every season.

The benefit of this sampling design is that it limits some of the natural variability in the system that can obscure important trends in the data. However, the tradeoff is that it is not possible to

extrapolate trends in the plots to the whole area without using additional information about the area (Miller and Ambrose 2000, Murray et al. 2006). In addition, data from the same place at different times are not statistically independent and therefore the types of statistical analyses appropriate for this study are limited (Murray et al. 2006). In order to determine if there are differences between plots in zones, or between the trends in the plots in zones (a "Zone x Time" interaction effect), a repeated-measures ANOVA will be conducted on all of the trends. The analysis is conducted using SYSTAT 9 software, with seasons as the within-subject variable (dependents), zones as the between-subject variable (factors) and cover as the response variable (independents). If a zone/time interaction is found, the zone and time analyses become meaningless (Underwood 2002).

If there is no significant ($p<0.05$) zone effect or zone/time interaction for a given species, all plots from all zones are averaged into a single trend for the whole park. If there is a significant difference in the time effect among the zones, the trends for each zone are considered separately. Trends are examined using a regression analysis (Microsoft Excel 2002). For each taxon, the goodness of fit (r^2) of the linear, second, and third-order polynomial are determined. The regression descriptive statistics (slopes and intercepts) are also reported.

Crosstab Analysis

Crosstab analysis queries are basic crosstab queries, which can show a single species, a group of species that start with the same characters, or all species. This analysis can be used to export data directly into an Excel workbook. See "Exporting to Excel." In order to perform a crosstab analysis on the photoplot or transect data, click on the appropriate tab on the MARINe Data Analysis page (Figure 17) to run the desired query.

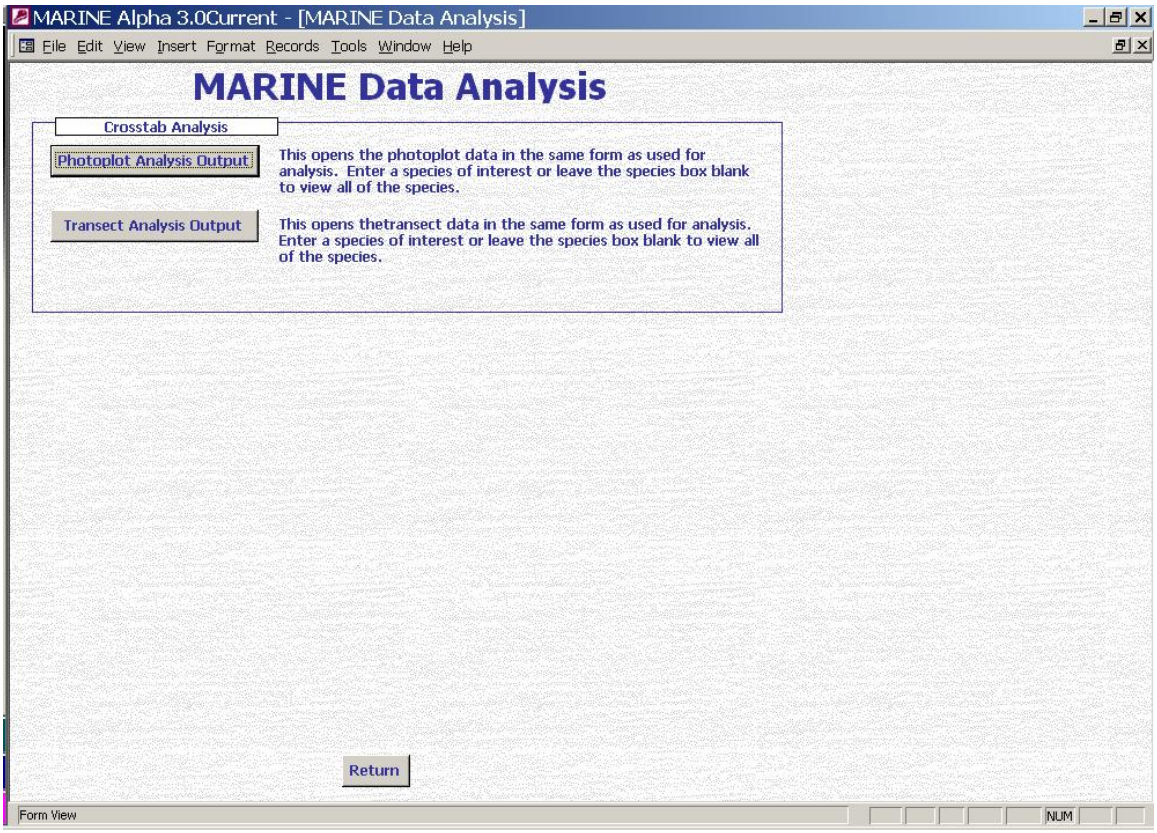

Figure 17. MARINe Data Analysis page.

Photoplot Analysis

When you click on the Photoplot Analysis button, you will be prompted to enter a species name or leave it blank for all species. You can enter a full species name or part of a name. The computer will return all species that start with the value you entered. Leaving the field blank will return all species.

Transect Analysis

The transect analysis works the same way as the photoplot analysis. When prompted, enter a species name, a part of a name, or leave it blank for all species.

Exporting to Excel

Run the analysis you want to export. After the result set is returned, click on the Tools menu, select Office Links, and choose Analyze It with Excel. Excel will open with the exported data. The file is written to the Windows default location. If you get a message that the file is too large, you must use the export command from the File menu. See Access help for instructions on its use.

Creating Summary Charts

Summary charts are created within the MARINe database by filling in the Summary Charts page.

Create annual summaries for the RNSP sites for:

1) Photoplots
2) Sea stars
    a) Mean per site
    b) Sized grouped by bins

The chart form (Figure 18) is divided into three sections:

1. Basic Information
    - Site – Select the site to be charted.
    - Target Species – Select the target species for photoplots. Not required for sea stars.
    - Start Period.
        - Photoplots – Use with End Period to select the range of seasons.
        - Sea stars – Use to select the season to be charted.
2. Select Species for Photoplots or Sea Stars.
    - Species 1…5 – Select one to five species to chart for photoplots or sea stars.
3. Chart Selection.
    - Photoplot Charts – Selected species charted for the selected species over the time period selected.
    - Photoplot Charts Error Bars – Photoplot charts with standard error bars.
    - Sea Star Size – Sea star abundance grouped into bins for selected site and season.
    - Sea Star Mean – Mean abundance for all plots at selected site for selected season.
    - Sea Star Mean –Mean chart with standard error bars.

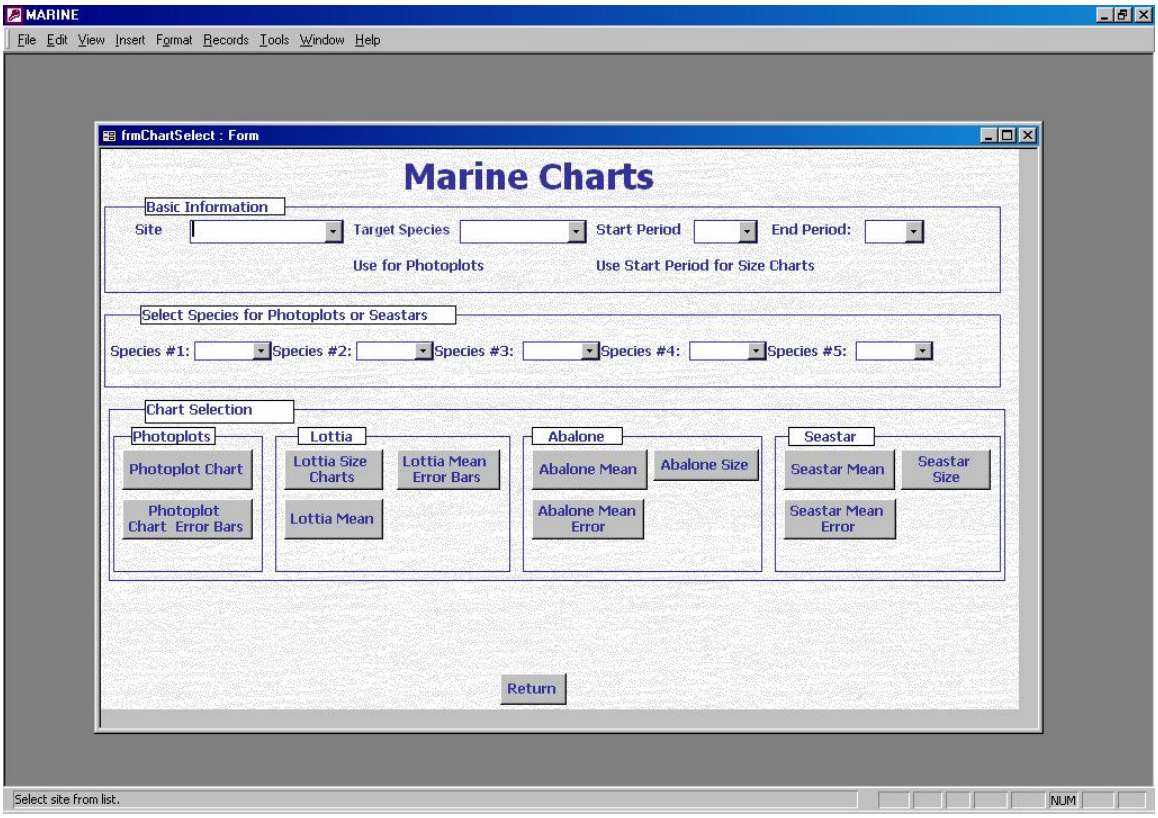

Figure 18. MARINe summary charts page.

Summary Table and Trend Graph Examples: Below are examples of photoplot summary (Table 10) and a summary of motile invert counts and size frequency (Table 11). Example trend graphs of acorn barnacles from the MARINe program (Figure 19) and RNSP (Figure 20) are also included.

Table 10. Photoplot summary of the mean percent cover by zone at Scorpion Rock, Santa Cruz Island, Spring 2004 (five plots/zone). (Channel Islands National Park rocky intertidal monitoring data excerpt.)

Zone	Bare Rock	Barnacle	Tetra-clita	Endo-cladia	Hespero-phycus	Silvetia	Mussels	Turf-weed	Leaf Barnacle	Misc Algae	Misc Animal	Other
Barnacle	36.4	17.2	0.0	25.8	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.4
Endocladia	28.4	4.0	0.4	53.8	0.0	0.2	1.4	0.0	1.4	10.0	0.2	0.2
Mussels	24.2	10.4	16.4	2.6	0.0	0.0	29.4	1.0	0.2	12.8	1.8	1.2
Tetraclita	55.4	3.6	11.4	3.8	0.0	0.0	13.4	0.0	3.0	7.2	1.6	0.6
Hespero-phycus	40.4	0.4	0.0	23.8	20.8	11.0	0.8	0.0	0.2	2.6	0.0	0.0

Table 11. Motile invertebrate (A) size frequency measurements (mm) and (B) counts for Scorpion Rock, Santa Cruz Island, Spring 2004. Channel Islands National Park rocky intertidal monitoring data excerpt.

A.

	Nucella emarginata	*Acanthina spp.*	*Tegula funebralis*	*Ceratostoma nuttali*	*Ocenebra circumtexta*	*Lottia gigantea*
Count	8	19	4	1	84	8
Average size	17	16	17	29	12	41
Minimum size	11	7	15	29	4	12
Maximum size	22	22	19	29	36	63

B.

Zone	**Barnacle**					**Endocladia**				
Plot #	**801**	**802**	**803**	**804**	**805**	**806**	**807**	**808**	**809**	**810**
Lepidochitona spp.							2	1		
Nuttalina spp.								1		
Fissurella volcano										
Pachygrapsis					4			3	2	
Pagurus spp.										
large limpets(>15mm)										
S. purpuratus									1	
Amphissa versicolor										
Nucella emarginata	1						3			
Acanthina spp.			1		3			1	2	
Tegula funebralis						1				
Ceratostoma nuttali										
Ocenebra circumtexta			1			2	2	3	5	8
Lottia gigantea										
Pisaster ochraceus										
Littorina spp.	325	2563	413	1363	938	253	197	253	344	1225
subsample1	3	94	18	48	18	41	24	56	75	37
subsample2	9	77	11	31	24	16	20	22	14	42
subsample3	14	34	4	30	33	24	19	3	21	19

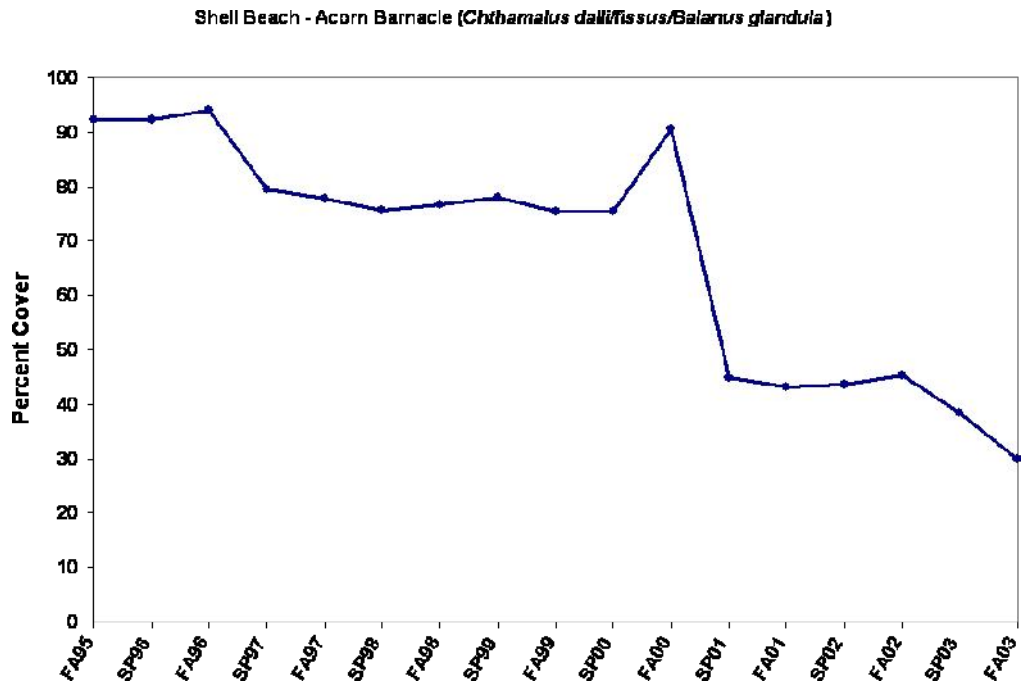

Figure 19. Example trend graphs from nine years of MARINe data for Acorn Barnacles Chthamalus dalli/fissus/Balanus glandula at Shell Beach in San Louis Obisbo County (from http://www.marine.gov/).

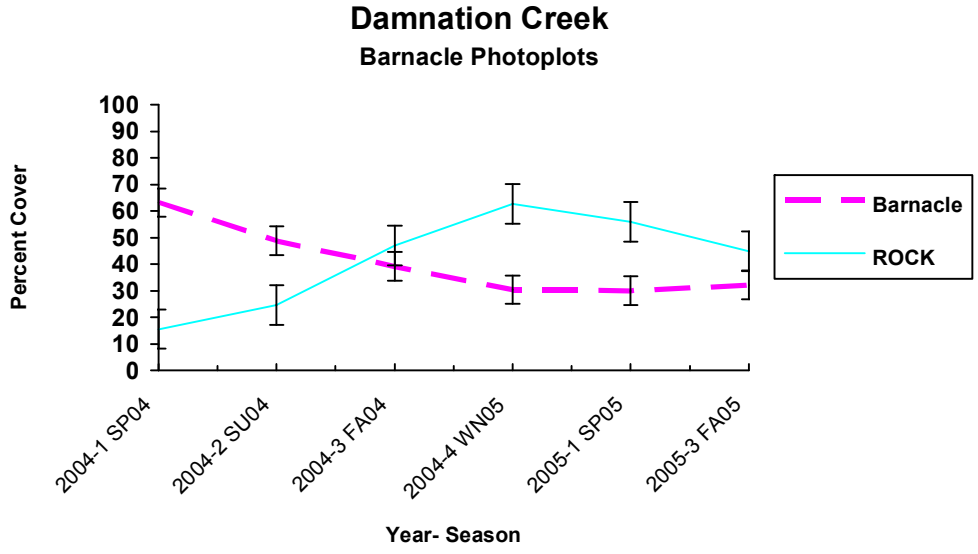

Figure 20. Example graph from two years of percent cover data for Acorn Barnacles Chthamalus dalli/fissus/Balanus glandula at Damnation Creek, RNSP.

Literature Cited

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SOP # 16: Revising the Protocol

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) explains how to make changes to the Redwood National and State Parks' Rocky Intertidal Monitoring Protocol, the narrative, and the accompanying SOPs, and how to properly track these changes. Any persons making changes to the protocol should first read this SOP to ensure that proper reviews are conducted and documentation standards are followed.

I. General Considerations

This Rocky Intertidal Monitoring Protocol, the narrative, and accompanying SOPs have been implemented using best-fit methodologies and protocols for the collection and analysis of long-term marine rocky intertidal resource data. However, standard protocol, regardless of how appropriate its method, will require editing as new and/or different information becomes available.

Any persons asked to edit the Protocol Narrative, or any of supporting SOPs, will need to follow this outlined procedure carefully in order to eliminate confusion as to which methods were employed when data were collected and analyzed. It is equally important to articulate any new or changed procedures as clearly and concisely as possible for credible interpretation of data acquired after the implementation of the change.

Procedure for Revising Protocol

1. For individual SOPs, edits should be made in a timely manner and may occur with, or without, review of this entire sampling protocol.

2. Edits are reviewed for both clarity and technical appropriateness. Small changes or additions to existing methods will be reviewed internally by Inventory and Monitoring (I&M) Natural Resources staff. If a complete change in methods is undertaken, then an outside review is required. We will utilize regional and/or national National Park Service (NPS) staff with expertise in appropriate marine research and data analysis as reviewers. Experts in research and statistical methodologies outside of the NPS, particularly with recognized academic affiliations, will also be utilized from time to time in the review process.

3. Document edits and protocol versioning in the **Revision History Log** (example below) which accompanies the protocol narrative and each SOP. Log changes to only that protocol narrative or SOP being edited. Version numbers increase incrementally by the hundredths (e.g., version 1.01, version 1.02, etc.), reflecting minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0, etc). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes were made, and the reason for making the changes. Assign the corresponding new version number.

4. Inform the Data Manager and I&M Resources person about changes to the protocol narrative or SOP, so that the new version number can be incorporated in the metadata of the project database. The database may have to be edited by the Data Manager to accompany changes in the protocol narrative and SOPs.

5. Post the updated version(s) to the intranet and intranet websites, NatureBib, and the Protocol database. When possible, notify and/or forward a copy of the revised protocol or narrative to individuals with a previous version.

Example of Logging a Change to Revision History Log

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
---	March 07	K.Cox	----	Original	1.00
1.00	**May 07**	**J. Smith**	**Added additional steps to SOP #16**	**Approved Modification to existing protocol**	**1.01**

SOP # 17: Project Deliverables

Version 1.00 (March 2008)

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) summarizes expectations for project deliverables in the Rocky Intertidal Monitoring Program at Redwood National and State Parks (RNSP). This document provides details on the process of submitting completed datasets, reports and other project deliverables. Attachment M provides a synopsis of who is responsible and the destination and target submission dates for specific deliverables. Procedures for sensitive data handling are also addressed.

I. Data Deliverables

The Project Lead is responsible for delivering the following to the Data Manager at the Klamath Network (KLMN) by October each year:

- Working MARINe database in MS Access format containing data from previous season(s) (SOP #14: Data Entry and Management including Uploading to the MARINe Database).
- Data certification report – A brief questionnaire that describes the certified data product(s) being submitted. The data certification report is in SOP #14: Data Entry and Management including Uploading to the MARINe Database.
- Metadata interview form – The metadata interview form is an MS Word questionnaire that greatly facilitates metadata creation. Details about reporting metadata and the form are in SOP #13: Metadata Guidelines.
- Digital overview and scored photoplot photographs and photograph metadata for the previous season(s). Digital photograph products are described in SOP #5: Photographing Plots and Taking Area Photos.
- Field data forms from the previous season(s). Data forms from all intertidal sampling methods are found in SOP #4-10.
- Updated data dictionary. If changes occur to the structure of the MARINe database, an updated data dictionary will be submitted.

II. Annual and Trend Reports

It is the responsibility of the Project Lead to develop the annual and trend reports in the proper format using current literature and data analysis tools available through the MARINe database (SOP #15: Data Analysis and Report Writing). Annual reports should be submitted to KLMN for review no later than October 1. The trend reports will be completed every five years (or when additional analyses are warranted). Once reviewed, the Project Lead should send the report to the Inventory and Monitoring (I&M) key official, by January of each year, for submission as a NPS technical report. Once approved, the report should be sent to the RNSP representative as a PDF. In addition, the PDF and all documents (e.g., .doc, .xls, .snp) incorporated into the PDF should be sent to the KLMN Data Manager in their original format no later than October of each year (SOP #15: Data Analysis and Report Writing).

III. Other Publications

The Project Lead, Data Analyst, Principal Investigator, members of the MARINe group or individuals of the public may publish scientific literature that includes data from the RNSP intertidal monitoring. Individuals or groups should seek permission from the project's Principal Investigator prior to using any data from the RNSP intertidal monitoring program. Sensitive data, such as specific coordinates, should not appear in publications (see section V). Publications that include RNSP intertidal data will be made available to KLMN for local park collections. Copies will be made available through the NPS database NatureBib.

IV. Storage and Posting of Project Deliverables

The posting and storage of all project deliverables will be coordinated by the Data Manager. Once the data has been stored and posted, the Project Lead will be notified that the year's data have been uploaded and successfully processed. The Data Manager will store, post, and use the products created as part of the intertidal monitoring effort in the following arrangement:

Annual Reports

Posted: The annual report is posted to the KLMN Internet and Intranet web sites. Electronic copies will be sent to the Resource Chiefs at each park in the Network and to any NPS staff associated with the project. A record will be created in NatureBib for each annual report and the NatureBib number will be added to the properties of the document. The report will be submitted to the NPS Natural Resource Technical Report series.

Timelines: Annual reports are posted to all the above locations and delivered to the Resource Chiefs within two weeks of receiving the document. Updates to the species list in NPSpecies and a new record in NatureBib will be created within one month of receiving the reports.

Stored: The annual report will be stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the KLMN network drive. Backups

will follow processes listed in the Klamath Network Data Management Plan (Mohren 2007)

.

Use: The KLMN will use these reports to update the KLMN I&M Program Annual Report. Annual reports will also be used to update the NPSpecies species lists.

Trend Reports

Posted: Trend reports will be posted to the KLMN Internet and Intranet web sites. Electronic copies will be sent to the Resource Chiefs at each park in the Network and to any NPS staff associated with the project. A record will be created in NatureBib for each trend report and the NatureBib number will be added to the properties of the document. The report will be submitted to the NPS Natural Resource Technical Report series.

Timelines: Trend reports are posted to all the above location and delivered to the Resource Chiefs within two weeks of receiving the document. Updates to the species lists in NPSpecies and a new record in NatureBib will be created within one month of receiving the reports.

Stored: The trend report will be stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the KLMN network drive. Backups will follow process listed in the Klamath Network Data Management Plan (Mohren 2007).

Use: Trend reports will be used to update the KLMN 5-year synthesis report.

Database

Posted: After being screened for sensitive information, a copy of the current database will be made available by contacting the KLMN Data Manager.

Timelines: After a holding period of two years, the Data Manager will upload the certified data to the NPS Data Store. This holding period is to protect professional authorship priority and to provide sufficient time to catch any undetected quality assurance problems.

Stored: The database will be stored in the Intertidal_Data folder, a subfolder of the Intertidal project folder located on the KLMN network drive. Backups will follow process listed in the Klamath Network Data Management Plan (Mohren 2007).

Use: Species listed as observed in the database will be compared to species on the RNSP species list located in the National I&M database, NPSpecies. If a species is in the MARINe database and not on the species list, the Project Manager and RNSP Lead will be contacted to determine if the new species should be added to the species list.

Metadata Interview Form

Posted: A parsed XML metadata record for the MARINe database will be posted on the NPS Data Store. The Metadata Interview Form will be used to update the metadata on the NPS Data Store.

Timelines: If needed, metadata will be updated and posted to the NPS Data Store within one month of receiving the Metadata Interview Form.

Stored: The Metadata Interview Form will be stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the KLMN network drive. Backups will follow process listed in the Klamath Network Data Management Plan (Mohren 2007).

Use: This form, along with the Data Dictionary, will be used to develop and update the metadata for the MARINe database. This form will also be used to determine if any sensitive data is contained in the database.

Photographs

Posted: Photographs are currently not posted for public use.

Timelines: All photographs will be inserted into the proper folders immediately upon delivery. Photographs and related metadata will be moved to the KLMN Image Database and KLMN Photographic Library within one month of receiving the electronic images.

Stored: Photographs will be stored in the Intertidal_Image folder, a subfolder of the Intertidal project folder located on the KLMN network drive. In addition, copies of each photograph will be placed in the KLMN Photographic Library. Backups will follow the process listed in the Klamath Network Data Management Plan (Mohren 2007).

Use: Pictures will be used in a variety of methods including reports, presentations, web sites, trainings, etc.

Photograph Metadata

Posted: Photograph metadata are currently not posted for public use.

Timelines: Photographs and related metadata will be moved to the KLMN Image Database and KLMN Photographic Library within one month of receiving the electronic images.

Stored: Metadata for each photograph is stored in the Intertidal_Image folder, a subfolder of the Intertidal project folder located on the KLMN network drive. Metadata for each photograph is uploaded to the KLMN Image Database, which is linked to the images in the KLMN Photographic Library. Backups follow

processes listed in the Klamath Network Data Management Plan (Mohren 2007).

Use: Photograph metadata is used to describe date, time, location, and other information about each picture in detail so photos can be used by current and future staff.

Product Certification Form

Posted: Product certification forms are not posted for public use.

Timelines: Product certification forms will be moved to the proper folder immediately upon delivery.

Stored: Product certification forms are stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the KLMN network drive. Backups follow processes listed in the Klamath Network Data Management Plan (Mohren 2007).

Use: These forms are used to track when a product was distributed to the KLMN.

Field Data Forms

Posted: Field forms are not posted for public use.

Timelines: Field forms will be converted to a PDF document and the electronic files will be stored in the project folder within two weeks of delivery. Field forms will be returned to the Project Lead within one month of receiving the forms.

Stored: Hardcopy field forms will be converted to a PDF and stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the KLMN network drive. Backups follow processes listed in the Klamath Network Data Management Plan(Mohren 2007). Hardcopy forms will be photocopied and stored in the proper locked file cabinet. Originals will be returned to the Project Lead.

Use: Field forms will be used to compare to the electronic data as issues arise. In addition, electronic versions of the forms will be available for archive and use by future park staff.

V. Sensitive Information

This section has been adapted from the Landbird Monitoring Protocol for National Parks in the North Coast and Cascades Monitoring Network (NCCN) Standard Operating Procedure (SOP) #19: Sensitive Information Procedures (Boetsch et al. 2005).

Although it is the general NPS policy to share information widely, the NPS also realizes that providing information about the location of park resources may sometimes place those resources at risk of harm, theft, or destruction. This can occur, for example, with regard to sensitive habitat and harvestable and/or rare plant and animal species. Therefore, information will be withheld when the NPS foresees that disclosure would be harmful to an interest protected by an exemption under the Freedom of Information Act (FOIA). The National Parks Omnibus Management Act, Section 207, 16 U.S.C. 5937, is interpreted to prohibit the release of information regarding the "nature or specific location" of certain cultural and natural resources in the national park system. Additional details and information about the legal basis for this policy can be found in the NPS Management Policies (National Park Service 2006), and in Director's Order #66.
These guidelines apply to all KLMN staff, cooperators, contractors, and other partners who are likely to obtain or have access to information about protected NPS resources. The Project Lead has primary responsibility for ensuring adequate protection of sensitive information related to this project.

The following are highlights of our strategy for protecting this information:

- *Protected resources*, in the context of the RNSP I&M Program, include species that have State- or Federally-listed status and other species deemed rare or sensitive by local park taxa experts.
- *Sensitive information* is defined as information about protected resources which may reveal the "nature or specific location" of protected resources. Such information must not be shared outside the NPS.
- In general, if information is withheld from one requesting party, it must be withheld from anyone else who requests it; if information is provided to one requesting party, it must be provided to anyone else who requests it.
- To share information as broadly as legally possible, and to provide a consistent, tractable approach for handling sensitive information, the following shall apply:
    - Removal of specific coordinates for data collection locations, and
    - Removal of data fields from the released copy that is likely to contain sensitive information.

What Kinds of Information Can and Cannot Be Shared?

Do not share: Project staff and cooperators should not share any information outside NPS that reveals details about the "nature or specific location" of protected resources, unless a confidentiality agreement is in place. Specifically, the following information should be omitted from shared copies of all data, presentations, reports, or other published forms of information.

- *Exact coordinates* – Including all GPS coordinates referencing site or plot locations.
- *Other descriptive location data* – Examples may include travel descriptions, location descriptions, or other fields that contain information which may reveal the specific location of the protected resource(s).
- *Protected resource observations at disclosed locations* – If specific location information has already been made publicly available, the occurrence of protected resources at that location cannot be shared outside NPS without a confidentiality agreement. For example, if the location for a monitoring site is posted to a web site or put into a publication, then at a later point in time a species of concern is observed at that monitoring station, that

sighting cannot be mentioned or referred to in any report, presentation, dataset, or publication that will be shared outside NPS.

Do share: All other information about the protected resource(s) may be freely shared, so long as the information does not reveal details about the "nature or specific location" of the protected resource(s) that aren't already readily available to the general public in some form (e.g., other published material). Species tallies and other types of data presentations that do not disclose the precise locations of protected resources may be shared, unless by indicating the presence of the species, the specific location is also revealed (i.e., in the case of a small park).

Details for Specific Products

Whenever products such as databases and reports are being generated, handled, or stored, they should be created explicitly for one of the following purposes:

1. *Public or general-use* – Intended for general distribution, sharing with cooperators, or posting to public web sites. They may be derived from products that contain sensitive information, so long as the sensitive information is either removed or otherwise rendered in a manner consistent with other guidance in this document.
2. *Internal NPS use* – These are products that contain sensitive information and should be stored and distributed only in a manner that ensures their continued protection. These products should clearly indicate that they are solely for internal NPS use by containing the phrase: "Internal NPS Use Only – Not For Release." These products can only be shared within NPS or in cases where a confidentiality agreement is in place. They do not need to be revised in a way that conceals the location of protected resources.

Datasets: To create a copy of a dataset that will be posted or shared outside NPS:

1. Remove any fields or tables that include GPS coordinates or maps to specific locations.
2. Delete the following MARINe database objects to ensure consistent omission of fields that may contain specific, identifying information about locations of protected resources:

TABLE_NAME tblSites

Field Name	Type	Required	Description
SiteLongitude	Number	N	The longitude of the site in decimal degrees to 5 decimal places (NAD 83) expressed as an negative number.
SiteLatitude	Number	N	The latitude of the site in decimal degrees to 5 decimal places (NAD 83).

The local, master copy of the database contains the exact coordinates and all data fields. The Data Manager can provide technical assistance as needed to apply coordinate offsets or otherwise edit data products for sensitive information.

Maps and Other GIS Output: General use maps and other geographic representations of observation data that will be released or shared outside NPS should be rendered using offset coordinates and should only be rendered at a scale that does not reveal their exact position (e.g., 1:100,000 maximum scale).

If a large-scale, close-up map is to be created using exact coordinates (e.g., for field crew navigation, etc.), the map should be clearly marked with the following phrase: "Internal NPS Use Only – Not For Release."

The Data Manager and/or GIS Specialist can provide technical assistance as needed to apply coordinate offsets or otherwise edit data products for sensitive information.

Presentations and Reports: Public or general use reports and presentations should adhere to the following guidelines:

1. Do not list exact coordinates or specific location information in any text, figure, table, or graphic in the report or presentation. If a list of coordinates is necessary, use only offset coordinates and clearly indicate that coordinates have been purposely offset to protect the resource(s) as required by law and NPS policy.
2. Use only general use maps as specified in the section on maps and other GIS output.

If a report is intended for internal use only, these restrictions do not apply. However, each page of the report should be clearly marked with the following phrase: "Internal NPS Use Only – Not For Release."

Voucher Specimens: Specimens of protected taxa should only be collected as allowed by law. Labels for specimens should be clearly labeled as containing sensitive information by containing the following phrase: "Internal NPS Use Only – Not For Release." These specimens should be stored separately from other specimens to prevent unintended access by visitors. As with any sensitive information, a confidentiality agreement should be in place prior to sending these specimens to another non-NPS cooperator or collection.

Literature Cited

Boetsch, J. R., B. Christoe, and R. E. Holmes. 2005. Data management plan for the North Coast and Cascades Network Inventory and Monitoring Program. National Park Service, Port Angeles, WA. Online. (http://www1.nature.nps.gov/im/units/nccn/datamgmt.cfm). Accessed 6 February 2007.

Mohren, S. R. 2007. Data Management Plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR—2007/012. National Park Service, Fort Collins, Colorado.

National Park Service Management Policies. 2006. Chapter 4: Natural resources

Attachment M. Schedule for Project Deliverables.

Deliverable Product	Primary Responsibility	Target Date	Destination(s)
Digital photographs and metadata	Project Lead	October 1 of the same year	KLMN Digital Library [1] KLMN Image Library [5]
Certified working database	Project Lead	October 1 of the same year	KLMN Digital Library [1], and NPS Data Store [2]
Data certification report	Project Lead	October 1 of the same year	KLMN Digital Library [1]
Metadata interview form	Project Lead	October 1 of the same year	KLMN Digital Library [1]
Full metadata (parsed XML)	Data Manager and Project Lead	October 1 of the following year	NPS Data Store [2], KLMN Digital Library [1]
Annual I&M report	Project Lead and Principal Investigator	October 1 of the following year	NatureBib [3], KLMN Digital Library [1], KLMN Internet and Intranet web pages, printout to local park collections, NPS Data Store [2], Natural Resource Technical Report Series
Field data forms	Project Lead	October 1	scanned PDF files in KLMN Digital Library [1], physical copies moved to park collections
5-10 year trend report	Data Analyst, Project Lead, and Principal Investigator	Every 5-10 years by October 1	NatureBib [3], NPS Data Store [2,] KLMN Digital Library [1], KLMN Internet and Intranet web pages, printout to local park collections, Natural Resource Technical Report Series
Other publications	Project Lead, Data Analyst, and Principal Investigator	as completed	NatureBib [3], KLMN Digital Library [1], KLMN Internet and Intranet web pages, NPS Data Store [2,] printout to local park collections
Other records	Project Lead	review for retention every January	retain according to NPS Director's Order #19 [4]

[1] The KLMN Digital Library is a hierarchical digital filing system stored on the KLMN file servers. Network users have read-only access to these files, except where information sensitivity may preclude general access.

[2] NPS Data Store is a clearinghouse for natural resource data and metadata (http://science.nature.nps.gov/nrdata). Only non-sensitive information is posted to NPS Data Store. Refer to the protocol section on sensitive information for details.

[3] NatureBib is the NPS bibliographic database (http://www.nature.nps.gov/nrbib/index.htm). This application has the capability of storing and providing public access to image data (e.g., PDF files) associated with each record.

[4] NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: http://www.nps.gov/refdesk/DOrders/DOrder19.html

Appendixes

Appendix A. Preliminary Assessment of RNSP Intertidal Sites

Appendix A is a report developed by Karah Cox, Cara McGary, Tim Mulligan, and Sean Craig from the Department of Fisheries Biology and Biological Sciences, Humboldt State University. The report is cited as:

Cox, K., and C. McGary. 2006. Marine resources of Redwood National and State Parks: Comprehensive report (2004-2005) for Humboldt and Del Norte County, California. REDW-00008.

The report documents the findings on a project designed to provide an account of algal, invertebrate, and fish biodiversity found in the nearshore habitats along a 35-mile coastline at Redwood National and State Parks (RNSP), and to describe the pattern of variability of the abundant and ecologically import species. The goals of the project were to: 1) create an exhaustive species list of the intertidal marine algae, invertebrates, and fish, 2) compare this list with previous studies conducted in RNSP (Boyd and DeMartin 1977 and 1981), 3) establish a voucher collection of identified specimens for use at RNSP, 4) establish baseline data on the intertidal communities of RNSP, 5) collect data on the spatial and temporal distribution of target species throughout the intertidal area, 6) present information that could be used to help assess damage caused by oil spills or other disturbance, and 7) set up a long-term program in order to monitor natural changes over time.

This report is associated with study #: REDW-00008; permit #:REDW-2004-SCI-0005 and can be found on the disk associated with this report or by going to the Klamath Network website at:

http://science.nature.nps.gov/im/units/klmn/Inventories/Intertidal/Craig_Intertidal.cfm

Appendix B. Effect of Temporal and Spatial Separation of Samples on Estimation of Impacts

Appendix B is the final technical summary and study report developed by Todd Minchinton and Peter Raimondi entitled Effects of Temporal and Spatial Separation of Samples on Estimation of Impacts. The citation for the document is:

Minchinton, T. E., and P. T. Raimondi. 2005. Effect of temporal and spatial separation of samples on estimation of impacts. MMS OCS Study 2005-002. Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, CA. MMS Cooperative Agreement Number 14-35-0001-30758.

Since 1991 the Mineral Management Service has funded a monitoring program for Santa Barbara County, California call the "Shoreline Inventory". The inventory was to provide baseline data on rocky intertidal communities that could be used in the event of an oil spill to calculate losses due to the impact. The primary objective of Minchinton and Raimondi's study was to use the database of the "Shoreline Inventory" to test quantitatively the critical assumption that estimation of consequences after an impact is possible for sites that were monitored before the impact.

This report is associated with OCS study #: MMS 2005-002 and can be found on the disk of supplemental materials associated with this report or by going to:

http://www.coastalresearchcenter.ucsb.edu/cmi/files/2005-002.pdf

Appendix C. MARINe Database User's Manual

Appendix C is the user guide associated with the MARINe Database that will be used to store the data collected as part of this protocol. Authors of the user guide are Bruce Bealer and Larry Cooper from Southern California Coastal Water Research Project, Westminster, CA. The current citation for the manual is:

Bealer, B., and L. Cooper. 2003. MARINe database user guide. Version 3.1. SouthernCalifornia Coastal Water Research Project, Westminster, CA.

The MARINe Data Management System provides a uniform data acquisition, information storage and retrieval system for the Multi-Agency Rocky Intertidal Network. The user guide provides details about the database including how the database is designed, data entry procedures, data maintenance, data analysis, and data extraction. The MARINE Database User Guide's current version is 3.1.

The document can be obtained from the disk of supplemental materials associated with this report, by contacting the Data Manager at the Klamath Inventory and Monitoring Network, or by contacting the MARINe organization.

Appendix D. Database Relationships and Data Dictionary for MARINe Database

Data Dictionary for MARINe Database

Table Design-Lookup Lists

TABLE_NAME luList01_SurveyingGroups

Field Name	Type	Required	Description
GroupCity	Text	Y	The group city.
GroupCode	Text	Y	A code used to identify each group.
GroupName	Text	Y	The group name.
GroupState	Text	Y	The group State. Default = CA
GroupStreetAddress	Text	Y	The street address of the group.
GroupZipCode	Text	Y	The group zip code
MonitoringGroup	Yes/No	Y	Is this a monitoring group? If yes, this group conducts seasonal surveys.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME luList02_Personnel

Field Name	Type	Required	Description
GroupCode	Text	Y	A code used to identify each agency.
Remarks	Text	N	Remarks
PersonnelMiddleInitial	Text	N	Middle Initial
PersonnelLastName	Text	Y	Last Name
PersonnelInitials	Text	Y	Initials
PersonnelID	Text	Y	Unique Personnel Identifier. A combination of Group code and a four digit sequential number. example: SCCWRP0001
LastDate	Date/Time	N	The last date this person participated. If a date is present then this person will not appear on personnel lists for new records.
FirstDate	Date/Time	Y	The first date this person participated.
ContactPhoneNumber	Text	N	The contact's phone number.
ContactInternalMailCode	Text	N	The internal mail code if available
ContactFaxNumber	Text	N	The contact's fax number
ContactEMail	Memo	N	The contacts EMail.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
PersonnelFirstName	Text	Y	First Name.

TABLE_NAME luList03_MARINECommonSeason

Field Name	Type	Required	Description
Year	Number	Y	The four digit calendar for this season.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
MCSSeason	Number	Y	A consecutive number used to order the surveying groups seasons. Used this field to sort the surveying seasons in calendar order.
SeasonCode	Text	Y	A four-character code to identify the Sampling season. The first two characters indicate the season and the last 2 characters indicate the year.
SeasonName	Text	Y	The common name of the season
SeasonSeq	Number	Y	The Season sequence within each year. 1=Spring, 2=Summer, 3=Fall, 4=Winter. Used with the year field as an alternate method to sort seasons in calendar order.

TABLE_NAME luList04_Methods

Field Name	Type	Required	Description
MethodCode	Text	Y	A code for the method
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	A description of the method

TABLE_NAME luList05_QualifierCodes

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	The description of the qualifier.
Qualifier	Text	Y	Used to modify the associated numeric field.
SeqNumber	Number	Y	Sequence Number. Use to control the sequence items appear in lists.

TABLE_NAME luList07_Units

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Unit	Text	Y	The unit of measure used.
UnitDescription	Text	Y	The description of the unit.

TABLE_NAME luList08_Roles

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
RoleDescription	Text	N	Description of the role.
RoleID	Number	Y	Unique Identifier for each person involved in the project
RoleName	Text	Y	The name of the role.

TABLE_NAME luList10_SurveyTypes

Field Name	Type	Required	Description
DataSource	Text	Y	The source of the data.
LoadDate	Date/Time	Y	The data the data was loaded.
SurveyTypeID	Number	Y	The ID of the type of survey.
SurveyTypeName	Text	Y	The name of the survey type.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME luList13_OchreSeastars

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
LottiaSize	Number	Y	The size of the lottia.

TABLE_NAME luList14_Counties

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
CountyCode	Text	Y	A unique Code for each county
CountyName	Text	Y	The county name

TABLE_NAME luList16_FieldLogValues

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	Description
Sequence	Number	Y	used to sequence the drop down boxes
Value	Text	Y	Values from the field log sheet.

TABLE_NAME luList17_FieldAbundance

Field Name	Type	Required	Description
AbundanceCode	Text	Y	The abundance code from field data sheet conditions
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	Description
Sequence	Number	Y	Used to control the display sequence

TABLE_NAME luList18_FieldConditions

Field Name	Type	Required	Description
Sequence	Number	Y	Used to control the order of items in a list.
Description	Text	Y	Description
ConditionsCode	Text	Y	A code indicating the species condition.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Sequence	Number	Y	Used to control the order of items in a list.

TABLE_NAME luList20_RecruitmentCode

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	The meaning of the code.
RecruitmentCode	Text	Y	A code for the recruitment state
Sequence	Number	Y	Used to control sequence

TABLE_NAME luList21_FieldEventBirds

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
BirdName	Text	Y	The common name of the bird.
Sequence	Number	Y	Used to sequence display of names in drop down lists.

TABLE_NAME luList22_FieldEventMam

Field Name	Type	Required	Description
Sequence	Number	Y	Used to sequence display of names in drop down lists
MammalName	Text	Y	The common name of the mammal.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent

Species System

TABLE_NAME organismConcept

Field Name	Type	Required	Description
ORGANISMREFERENCE_ID	Number	Y	This is a foreign key to the reference in which the name was used, thereby defining a concept.
ORGANISMCONCEPT_ID	Number	Y	Database assigned value to each unique record in the commConcept table.
ORGANISMLevel	Text	N	The classLevel attribute specifies a level in the taxonomic hierarchy that a class belongs.
ORGANISMNAME_ID	Number	Y	This is the foreign key into the plant name list, the entry in which when combined with a reference constituted a concept.
ORGANISMParent	Number	N	The organismParent is a recursive key to the concept of the parent level in the classification
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME organismCorrelation

Field Name	Type	Required	Description
ORGANISMSTATUS_ID	Number	Y	This is the foreign key into the organismStatus table "pointing" to a concept no longer viewed as standard by the party. Reference "pointing" to a concept no longer viewed as standard by the party. Reference organismStatus.ORGANISMSTATUS_ID
PhotoPlotsCoreSpecies	Yes/No	Y	Is this a core photoplot species?
SixLetterCode	Text	Y	A six-letter code for analysis output.
SpeciesCoreFlag	Yes/No	Y	Is this species a core MARINE species?
TargetSpecies	Yes/No	Y	Is this a target species?
TransectsCoreSpecies	Yes/No	Y	Is this a transect species?
correlationStop	Date/Time	N	This is the stop date for recognition by a party of a correlation between two concepts.
TargetSpecies	Text	Y	Is this a target species?
ORGANISMCONCEPT_ID	Number	N	This is the foreign key into the organismtConcept table "pointing" to a concept recognized by the party as a "standard" concept.
organismConvergence	Text	N	This is the descriptive attribute that is used to relate the congruence between two concepts.
correlationStart	Date/Time	Y	This is the start date for recognition by a party of a correlation between two concepts.
CircularPlotCoreSpecies	Yes/No	Y	Is this a circular plot species?
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
AbaloneSeastarsCore	Yes/No	Y	Is this a Abalone/Seastar species?
ORGANISMCORRELATION_ID	Number	Y	Database assigned value to each unique record in the organismCorrelation table.

TABLE_NAME organismLineation

Field Name	Type	Required	Description
ORGANISMSTATUS1_ID	Number	Y	This is the foreign key into the organismStatus table "pointing" to a child concept. Reference organismStatus.ORGANISMSTATUS_ID
ORGANISMSTATUS2_ID	Number	Y	This is the foreign key into theorganismStatus table "pointing" to parent concept. Reference organismStatus.ORGANISMSTATUS_ID
ORGANISMLINEAGE_ID	Number	Y	Database assigned value to each unique record in the organismLineage table
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME organismName

Field Name	Type	Required	Description
ORGANISMREFERENCE_ID	Number	N	Foreign key into the organismReference table to identify the original source of the name (usually the type description). Reference organismReference.ORGANISMREFERENCE_ID
dateEntered	Date/Time	N	Field stores the date that the name was entered into the database.
organismName	Text	N	The organism name.
ORGANISMNAME_ID	Number	Y	Database assigned value to each unique record in the organismName table.
organismNameWithAuthor	Text	N	The organism name with any with author notation embedded.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME organismParty

Field Name	Type	Required	Description
ORGANISMPARTY_ID	Number	Y	Database generated identifier assigned to each unique party
salutation	Text	N	Salutation preceding one's given name.
owner	Number	N	recursive foreign key to the Party who owns this party record and who has exclusive rights to update the information
originizationName	Text	N	Name of an organization.
middleName	Text	N	One's middle name or initial, if any.
givenName	Text	N	One's first name.
currentName	Number	N	Recursive foreign key to current name of this party. Reference organismParty.ORGANISMPARTY_ID
Reference organismParty.ORGANISMPARTY_ID			
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
surName	Text	N	Name shared in common to identify the members of
a family, as distinguished from each member's given			
contactInstructions	Text	N	Instructions for contacting a party.

TABLE_NAME organismReference

Field Name	Type	Required	Description
ORGANISMREFERENCE_ID	Number	Y	Database assigned value to each unique record in the organismReference table
title	Text	N	Name by which the cited reference is known.
tableCited	Text	N	name/number of published table containing plant name
seriesName	Text	N	Name of a series.
pubDate	Date/Time	N	Date the citation was published
page	Text	N	Page of the book or serial where the article appears.
otherCitationDetails	Text	N	Other information identifying the issue of the series.
issueIdentification	Text	N	Information identifying the issue of the series.
ISSN	Text	N	International Standard Serial Number.
ISBN	Text	N	International Standard Book NUmber
edition	Text	N	Version of the cited resource.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
organismDescription	Memo	N	Description of the organism. Used where the organismReference table record serves as a self reference for purposes of establishing a taxon concept(taxon assertion). Primary used for nonstandard taxa used by field ecologists, such as "Hariry grass #3".
authors	Text	N	Names of the authors as they appear within the entity being cited.

TABLE_NAME organismStatus

Field Name	Type	Required	Description
organismConceptStatus	Text	N	Status of the concept by the party (accepted, not accepted, undetermined).
stopDate	Date/Time	N	This is the date which the status assignment by the party ended.
startDate	Date/Time	N	This is the date which the status assignment by the party started.
ORGANISMSTATUS_ID	Number	Y	Database assigned value to each unique record in the organismStatus table.
ORGANISMREFERENCE_ID	Number	N	Link to a reference where the status was reported. Reference organismReference.ORGANISMREFERENCE_ID
organismReference.ORGANISMREFERENCE_ID			
ORGANISMPARTY_ID	Number	N	Foreign key that identifies the party that madn the status assignment. Reference organismParty.ORGANISMPARTY_ID
ORGANISMCONCEPT_ID	Number	N	Foreign key to identify the concept to which a party assigns a status.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
organismPartyComments	Text	N	Comments by party providing rationale for status assignment.

TABLE_NAME organismUsage

Field Name	Type	Required	Description
ORGANISMNameStatus	Text	Y	This field shows the status of the application on the name to the concept by the party
usageStart	Date/Time	Y	This is the date on which the party applied the name to the concept.
usageStop	Date/Time	N	This is the date on which the party ceased to apply the name to the concept.
ORGANISMPARTY_ID	Number	N	Foreign key that identifies the party that uses the concept with the name
ORGANISMCONCEPT_ID	Number	Y	This is the foreign key into the organismConcept table. Reference
classSystem	Text	N	This is the name of the classification sustem wherin the name is applied (e.g., EnglishCommon of Scietific).
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
ORGANISMUSAGE_ID	Number	Y	Database assigned value to each unique record in the organismUsage table.
ORGANISMNAME_ID	Number	Y	This is the foreign key into the organismName table. Reference plantName.ORGANISMNAME_ID

Information Tables

TABLE_NAME tblCountSizePlotInfo

Field Name	Type	Required	Description
CountSizePlotTargetSpecies	Text	Y	The species the plot was set up to measure.
GroupCode	Text	Y	A code for the group responsible for the measurement. The code must come from
CountSizePlotMethod	Text	N	The method used.
CountSizePlotLoadDate	Date/Time	Y	The date the data was loaded or changed.
CountSizePlotID	Text	Y	The ID of the Plot
CountSizePlotEffectiveEndDate	Date/Time	N	The last date this plot configuration was effective.
CountSizePlotDataSource	Text	Y	The source of the data. This will be the submissionID on all new data.
CountSizePlotComments	Text	N	Additional remarks
CountSizePlotAreaUnits	Text	N	The unit of measurement for the Plot area. Default is "CM" centimeters. From luList7_Units.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
CountSizePlotArea	Number	N	The area of the Plot.
CountSizePlotDateEstablished	Date/Time	N	The date this plot configuration became effective.
SiteID	Text	Y	The siteID of site where the measurement was taken.

TABLE_NAME tblDataTransmission

Field Name	Type	Required	Description
DateStamp	Date/Time	Y	Date and Time the file was made.
SendFilename	Text	Y	Name of the file that had the data tables in it.

TABLE_NAME tblEventBirds

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
SiteID	Text	Y	The siteID
LoadDate	Date/Time	N	The date the date was loaded or changed
GroupCode	Text	Y	The surveying group
DataSource	Text	N	The source of the data. This will be the submissionID on all new data. Initial data load
Bird Count	Number	Y	The number of birds encountered.
SurveyDate	Date/Time	Y	The date of the survey.
BirdName	Text	Y	The Bird name from the luList21_FieldEventBirds

TABLE_NAME tblEventMammals

Field Name	Type	Required	Description
MammalCount	Number	Y	The number of Mammals encountered.
SiteID	Text	Y	The site ID
SurveyDate	Date/Time	Y	The date of the survey.
MammalSpeciesCode	Text	Y	The Species code from the lulist22_FieldEventMammals
GroupCode	Text	Y	The surveying group code
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
DataSource	Text	N	The source of the data. This will be the submissionID on all new data. Initial data load
LoadDate	Date/Time	N	The date the data was loaded or changed

TABLE_NAME tblEventParticipants

Field Name	Type	Required	Description
LoadDate	Date/Time	N	The date the data was loaded or changed
SurveyDate	Date/Time	Y	The date of the survey
ParticipantPersonnelID	Text	Y	The personnelID of the participant. From luList2_Personnel
GroupCode	Text	Y	The surveying Group.
DataSource	Text	N	The source of the data. This will be the submissionID on all new data. Initial data load
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
SiteID	Text	Y	The Siteid

TABLE_NAME tblFieldLogEvents

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
HumansReef	Number	N	The number of people on the reef
OilTar	Text	N	The level of oil or tar. From luList16_FieldLogValues
OtherNotes	Memo	N	The trip report
LoadDate	Date/Time	N	The date the data was loaded
HumansSand	Number	N	The number of people at the beach.
HumansNotes	Text	N	Notes about the humans on the beach.
GroupCode	Text	Y	The surveying group from luList01_SurveyingGroup
Driftwood	Text	N	The level of driftwood. From luList16_FieldLogValues
DeadAnimals	Text	N	The level of dead animals. From luList16_FieldLogValues
BirdMammalNotes	Memo	N	Bird/Mammal Notes
PlotNotes	Memo	N	Event metadata
DataSource	Text	N	The source of the data. This will be the submissionID on all new data. Initial data load
TideLevelTime	Date/Time	N	The time the tide level was measured
PlantWrack	Text	N	The level of plant wrack. From luList16_FieldLogValues
Wind	Text	N	Wind speed (ND=No Data; 0=None; L=Low; M=Med.; H=High; or Actual Value)
Trash	Text	N	The level of trash. From luList16_FieldLogValues
TideLevelFeet	Number	N	The tide level in feet
SurveyStartTime	Date/Time	N	The time of day the survey started.

SurveyEndTime	Date/Time	N	The time the survey ended.
SurveyDate	Date/Time	Y	The date of the survey.
Surge	Text	N	A description of the surge. From luList16_FieldLogValues
SiteID	Text	Y	The ID of the site surveyed.
ShellDebris	Text	N	The level shell debris. From luList16_FieldLogValues
RecentRain	Text	N	Level of recent rain. From luList16_FieldLogValues
WaterTemperature	Text	N	Description of water tempature or actual value. Actual value in Degrees °C
SedimentLevel	Text	N	luList16_FieldLogValues
PhysicalConditionNotes	Memo	N	Notes on physical conditions
Rain	Text	N	Rain at the site during surveying
Recorder	Text	Y	The personnelID of the recorder
RockMovement	Text	N	The level of rock movement. From luList16_FieldLogValues
SampleSeason	Number	Y	The Survey Season
SamplingSeasonCode	Text	Y	A code for the survey season. The first are the season and the last two numbers are the year. Example FA01 = Fall 2001
Scour	Text	N	The level of scour. From lu

TABLE_NAME tblOptionalPhotoSpecies

Field Name	Type	Required	Description
GroupCode	Text	Y	The code of the group needing the additional (optional) species
SpeciesLong	Text	Y	The full name of the species.
Seqnum	Number	Y	This controls the order of display on the frmPhotoPlotDataEntry for optional species
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Species	Text	Y	This is the species loaded into the label for each results on frmPhotoPlotDataEntry for optional

TABLE_NAME tblOptionalTransectSpecie

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
GroupCode	Text	Y	The code of the group needing the additional (optional) species
Seqnum	Number	Y	This controls the order of display on the frmPhotoPlotDataEntry for optional species
Species	Text	Y	This is the species loaded into the label for each results on frmPhotoPlotDataEntry for optional
SpeciesLong	Text	Y	The full species name.

TABLE_NAME tblParameters

Field Name	Type	Required	Description
Value	Text	N	The parameter value.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Code	Text	N	The parameter code
Description	Text	N	Description

TABLE_NAME tblPhotoPlotInfo

Field Name	Type	Required	Description
EffectiveEndDate	Date/Time	N	The last date this plot configuration was effective.
TargetSpecies	Yes/No	Y	The target species the plot was set up to measure.
SiteID	Text	Y	The siteID of site where the measurement was taken.
QuadNumber	Text	Y	The replicate quadrat number.
PhotoPlotAreaUnits	Text	N	The unit of measurement for the Plot area. Default is "CM" centimeters. From luList7_Units
TargetSpecies	Text	Y	The target species the plot was set up to measure.
PhotoPlotArea	Number	N	The area of the Plot.
GroupCode	Text	Y	A code for the group responsible for the measurement. The code must come from
DateEstablished	Date/Time	N	The date this configuration or the plot was established.
DataSource	Text	Y	The source of the data.
Comments	Text	N	Additional remarks
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
LoadDate	Date/Time	Y	The date the data was loaded or changed.

TABLE_NAME tblPersonnelRoles

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
PersonnelID	Text	Y	A unique identifier for each person. From luList2_Personnel
RoleID	Number	Y	The role ID from luList8_Roles

TABLE_NAME tblPhotoPlots

Field Name	Type	Required	Description
SampleSeason	Number	Y	Consecutive sampling number.
whoscored	Text	N	The person who scored the pictures.
TargetSpecies	Text	N	Target species that plot has been set up to monitor
TargetSpecies	Yes/No	N	Target species that plot has been set up to monitor
SurveyDate	Date/Time	N	The date the survey was taken.
Species	Text	N	Species being counted.
SiteID	Text	Y	Name of the site sampled .
ScoringMethod	Text	N	Field or Lab
SamplingSeasonCode	Text	Y	Sampling season, SP=Spring F=Fall plus the last 2 digits of the year
Qualifier	Text	N	Flag for count
QuadNumber	Text	Y	Replicate quadrat number, starting from 1 for each target species. Size: 50 cm x 75 cm
PctCover	Number	N	Percent of cover.
OriginalSpecies	Text	N	The species as originally recorded on the data sheets. Used for historical reference.
LoadDate	Date/Time	N	The date the data was loaded
GroupCode	Text	Y	Group doing the count
DataSource	Text	N	The data submission ID that supplied this data. Initial data is coded "IDL" Initial Data Load
Comments	Text	N	Additional remarks
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
SampleSeason	Number	Y	Consecutive sampling number.

TABLE_NAME tblPhotoSpecies

Field Name	Type	Required	Description
Species	Text	Y	The Six Letter Code from the Species System
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
SpeciesLong	Text	Y	The full name from the Species System
Seqnum	Number	Y	This field controls the display order on the Photo Plot Data Entry

TABLE_NAME tblReconnaissance

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Condition	Text	Y	Description of the condition. From luList18_FieldConditions
GroupCode	Text	Y	The surveying group from luList 01 SurveyingGroups
SurveyingGroups			
Notes	Text	N	Additional Remarks
Recruitment	Text	Y	The level of recruitment from luList 20_RecruitmentCodes
SiteID	Text	Y	The site id from tblSites
SpeciesName	Text	Y	The species name from the species system
SurveyDate	Date/Time	Y	The date the survey was taken expressed as dd/mmm/yyyy
Abundance	Text	Y	Description of the abundance found.

TABLE_NAME tblRecruteSpecies

Field Name	Type	Required	Description
Species	Text	Y	Species name.
MidZone	Yes/No	Y	Is this found in the mid zone.
TargetSpecies	Yes/No	Y	Is this a target species
HighZone	Yes/No	Y	Is this found in the high zone.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
DisplaySequence	Number	N	Used to control display sequence
TargetSpecies	Text	Y	Is this a target species
LowZone	Yes/No	Y	Is this found in the low zone.

TABLE_NAME tblSites

Field Name	Type	Required	Description
LoadDate	Date/Time	N	The date the data was loaded or changed
SiteName	Text	Y	The name of the site location. Example Crystal Cove
SiteLongitude	Number	N	The longitude of the site in decimal degrees to 5 decimal places (NAD 83) expressed as an negative number
SiteLatitude	Number	N	The latitude of the site in decimal degrees to 5 decimal places (NAD 83)
PIID	Text	N	The personnel ID of the Principal Investigator who originally established the site. Must be in the luList2_Personnel and have a role of Principal Investigator.
IslandCode	Text	Y	A code for Island or Mainland. From luList9_Islands
FundingAgency	Text	Y	The agency funding the establishment of surveys at the site
Datum	Text	N	The datum used to establish the site.
DateEstablished	Date/Time	N	The date the site was established.
DataSource	Text	Y	The source of the data. This will be the submissionID on all new data. Initial data load
CountyCode	Text	Y	The county in which the site is located. From luList14_Counties
Comments	Text	N	Comments
EstablishingGroupCode	Text	Y	The code of the surveying group responsible for the establishment of site. Must be in luList1_SurveyingGroups
SiteID	Text	Y	The Unique ID assigned to each Site

TABLE_NAME tblSpeciesCountSize

Field Name	Type	Required	Description
Timed SearchEnd Time	Date/Time	N	The time the timed search ended.
SiteID	Text	Y	The site ID
TimedSearchStartTime	Date/Time	N	The time the timed search started.
SizeUnit	Text	N	The unit of measure for the size
SizeQualifier	Text	N	A description of the size from luList5_Qualifiers
SpeciesCount	Number	Y	The species count
SpeciesSize	Number	N	The size of the species found
SurveyDate	Date/Time	Y	The date the survey was taken.
TargetSpecies	Text	Y	From the luList6_Species
SamplingSeasonCode	Text	Y	An alpha code for the sample season
TargetSpecies	Yes/No	Y	From the luList6_Species
CountSizeTime	Date/Time	N	The time the survey was taken. Not used on all surveys.
SampleSeason	Number	Y	The Surveying Season
Species	Text	Y	The species encountered
Comments	Text	N	Comments
DataSource	Text	N	The source of the data
GroupCode	Text	Y	The surveying group
LoadDate	Date/Time	N	The data the data was loaded
MethodCode	Text	Y	The method used.
OriginalSpecies	Text	N	The species as originally recorded on the data sheets. Used for historical reference.
PlotID	Text	Y	The plot number
SampleSeason	Number	Y	The Surveying Season
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME tblSurveyDataCollectors

Field Name	Type	Required	Description
LoadDate	Date/Time	N	The data the data was loaded.
SiteID	Text	Y	The siteid of the site surveyed.
TargetSpecies	Text	Y	The target species.
TargetSpecies	Yes/No	Y	The target species.
SurveySeasonCode	Text	Y	The season code for this season. From luList03_MarineCommonSeason
SurveyDate	Date/Time	Y	The date the survey was taken.
SampleSeason	Number	Y	The MCS Season number.
SampleSeason	Number	Y	The MCS Season number.
PersonnelID	Text	Y	The personnel ID of the person doing the data collection.
GroupCode	Text	Y	The Surveying Group
DataSource	Text	N	The source of the data.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
RoleID	Number	Y	The role ID for the type of activity the data collector preformed

TABLE_NAME tblTransectInfo

Field Name	Type	Required	Description
GroupCode	Text	Y	A code for the group responsible for the measurement.
TargetSpecies	Text	N	The target species the transects was set up for.
TargetSpecies	Yes/No	N	The target species the transects was set up for.
SiteID	Text	Y	The siteID of site where the measurement was taken.
TransectNumber	Text	Y	The replicate transect number.
LoadDate	Date/Time	Y	The date the data was loaded
DateEstablished	Date/Time	N	The date this transect configuration was established.
DataSource	Text	Y	The source of the data. This will be the submissionID on all new data. Initial data load
Comments	Text	N	Additional remarks
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
MethodCode	Text	N	The method used for the transect.
EffectiveEndDate	Date/Time	N	The last date this configuration was effective

TABLE_NAME tblTransects

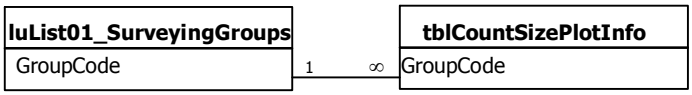
Field Name	Type	Required	Description
SampleSeason	Number	N	Consecutive sampling number
TransectNumber	Text	Y	Replicate transect number, starting from 1. Length: 10 m
TargetSpecies	Text	Y	The initial species the transect was created.
SurveyDate	Date/Time	N	The date the survey was taken.
Species	Text	Y	The species counted FK to the luList6_SpeciesList
SiteID	Text	Y	Name of the site sampled (see Appendix A for full site names and counties). site names and counties).
SampleSeason	Number	N	Consecutive sampling number
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
PctEncountered	Number	N	Percent Encountered. Used to be called SpeciesCount
OriginalSpecies	Text	N	The species as originally recorded on the data sheets. Used for historical reference.
MethodCode	Text	N	The method used for the transect.
LoadDate	Date/Time	Y	The data the data was loaded
GroupCode	Text	Y	The Group Conducting the count.
DataSource	Text	Y	The submission id of the data
Comments	Text	N	Supporting Remarks.
Qualifier	Text	N	A qualifier code for the counts FK to luList5_QualifierCodes
SamplingSeasonCode	Text	Y	Survey season descriptive code.

TABLE_NAME tblTransectSpecies

Field Name	Type	Required	Description
SpeciesLong	Text	N	The full name from the Species System
Species	Text	N	The Six Letter Code from the Species System
Seqnum	Number	N	This field controls the display order on the Transect Data Entry
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

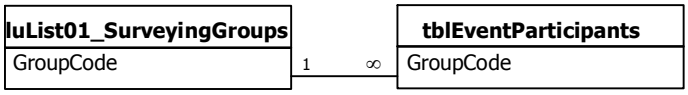
Relationships for the MARINe Database

luList01_SurveyingGroupstblCountSizePlotInfo



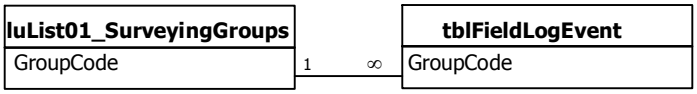
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblEventParticipants



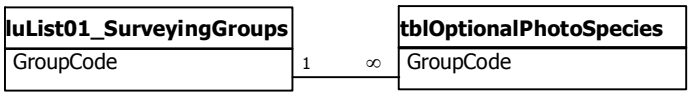
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblFieldLogEvent



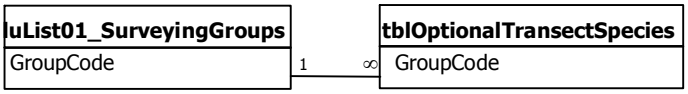
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblOptionalPhotoSpecies



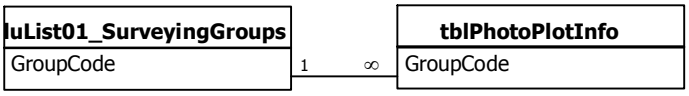
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblOptionalTransectSpecies



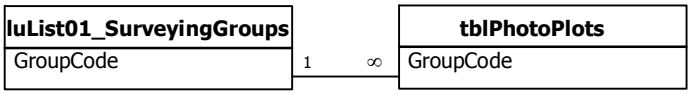
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblPhotoPlotInfo



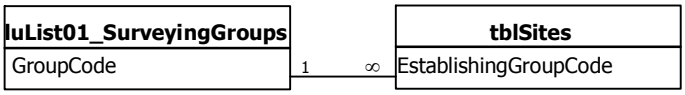
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblPhotoPlots



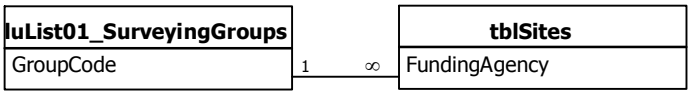
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblSites



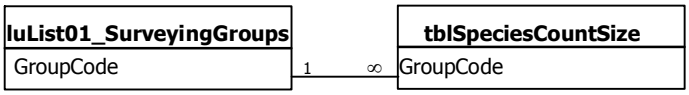
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblSites



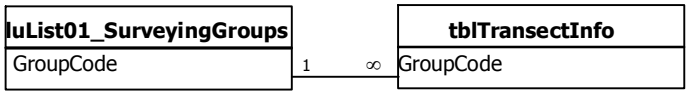
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblSpeciesCountSize



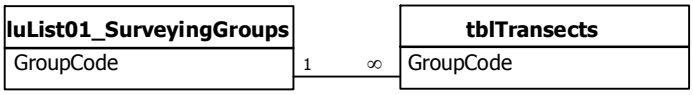
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblTransectInfo



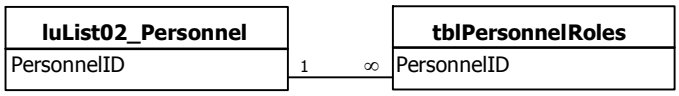
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblTransects



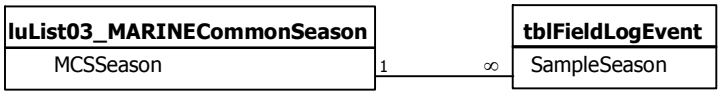
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList02_PersonneltblPersonnelRoles



Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList03_MARINECommonSeasontblFieldLogEvent

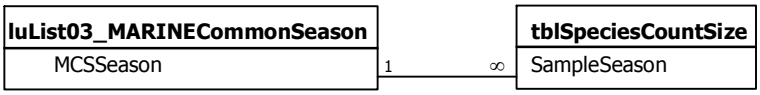


Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList03_MARINECommonSeasontblFieldLogEvent

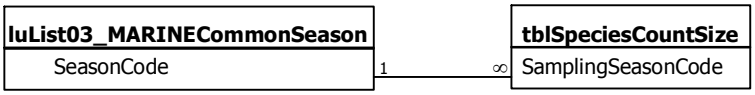
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList03_MARINECommonSeasontblSpeciesCountSize



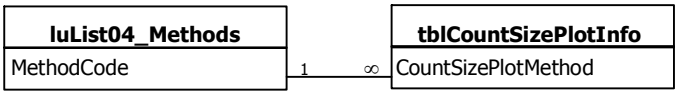
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList03_MARINECommonSeasontblSpeciesCountSize



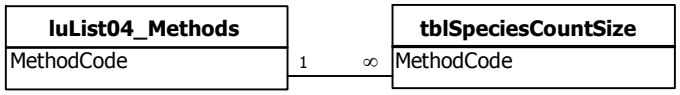
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList04_MethodstblCountSizePlotInfo



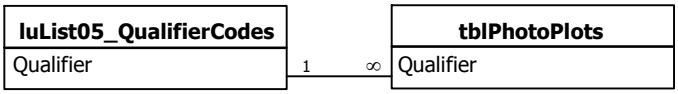
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList04_MethodstblSpeciesCountSize



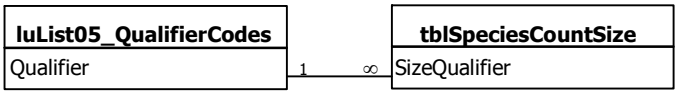
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList05_QualifierCodestblPhotoPlots



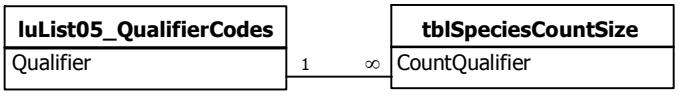
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList05_QualifierCodestblSpeciesCountSize



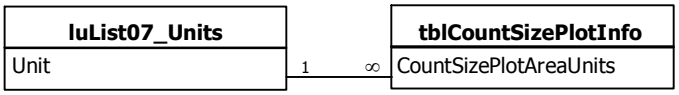
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList05_QualifierCodestblSpeciesCountSize



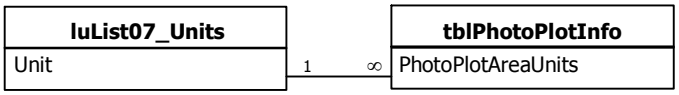
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList07_UnitstblCountSizePlotInfo



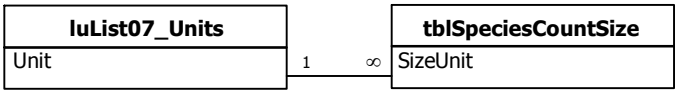
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList07_UnitstblPhotoPlotInfo



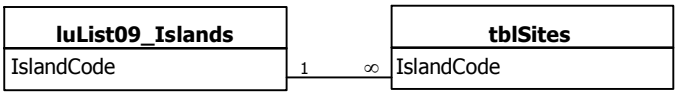
Attributes: Enforced
RelationshipType: One-To-Many

luList07_UnitstblSpeciesCountSize



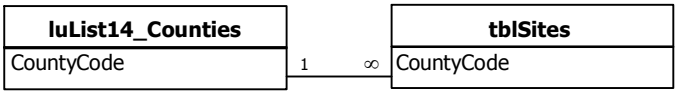
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList09_IslandstblSites



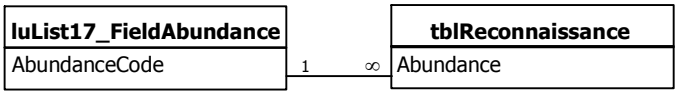
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList14_CountiestblSites



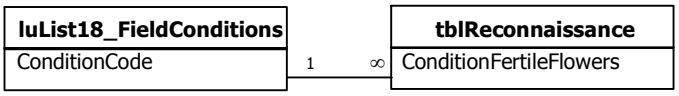
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList17_FieldAbundancetblReconnaissance



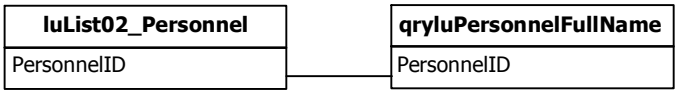
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList18_FieldConditionstblReconnaissance



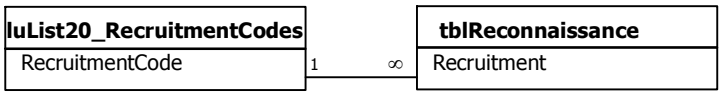
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList02_PersonnelqryluPersonnelFullName



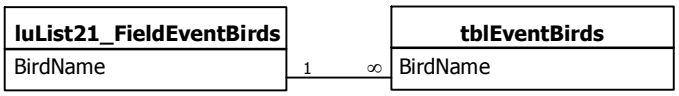
Attributes: Not Enforced
RelationshipType: One-To-Many

luList20_RecruitmentCodestblReconnaissance



Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList21_FieldEventBirdstblEventBirds

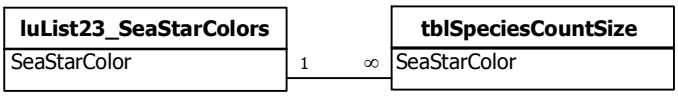


Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList22_FieldEventMammalstblEventMammals

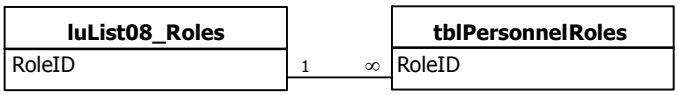
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList23_SeaStarColorstblSpeciesCountSize



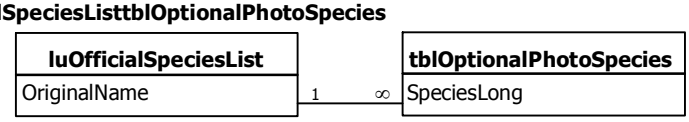
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList08_RolestblPersonnelRoles



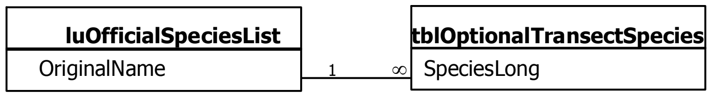
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblOptionalPhotoSpecies



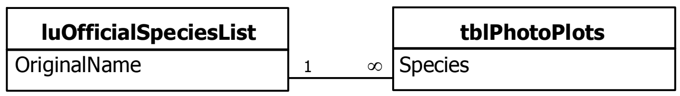
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblOptionalTransectSpecies



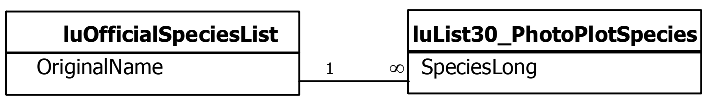
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblPhotoPlots



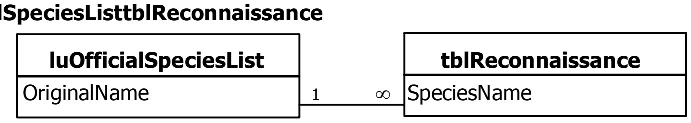
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListluList30_PhotoPlotSpecies



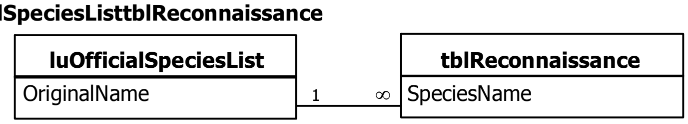
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblReconnaissance



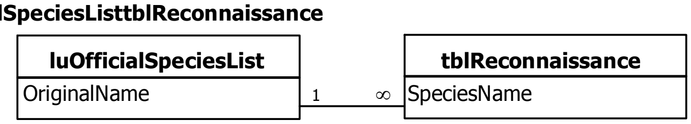
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblReconnaissance



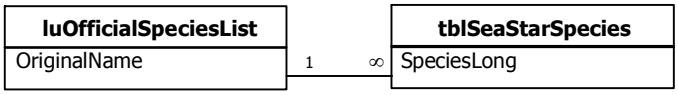
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblReconnaissance



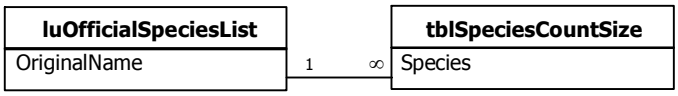
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblSeaStarSpecies



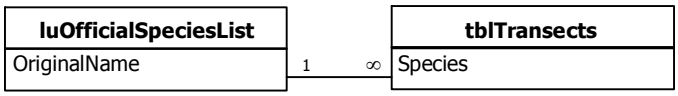
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblSpeciesCountSize



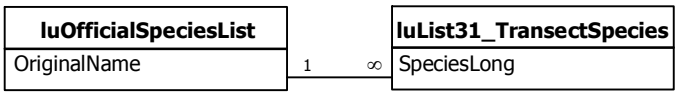
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblTransects



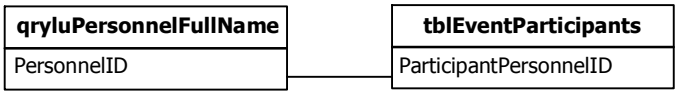
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListluList31_TransectSpecies



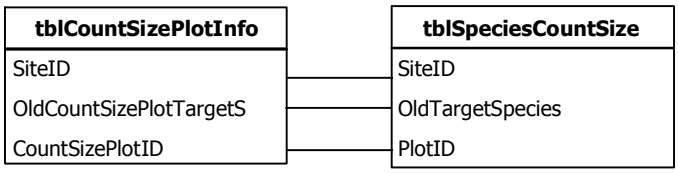
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

qryluPersonnelFullNametblEventParticipants



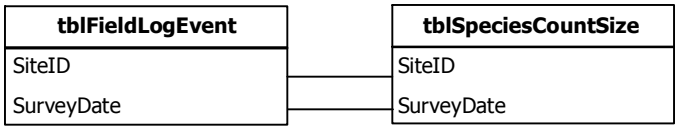
Attributes: Not Enforced
RelationshipType: Indeterminate

tblCountSizePlotInfotblSpeciesCountSize



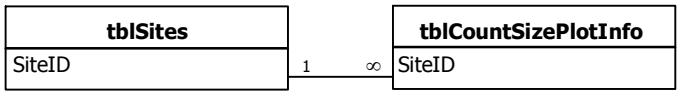
Attributes: Not Enforced
RelationshipType: Indeterminate

tblFieldLogEventtblSpeciesCountSize



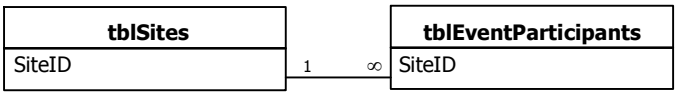
Attributes: Not Enforced
RelationshipType: Indeterminate

tblSitestblCountSizePlotInfo



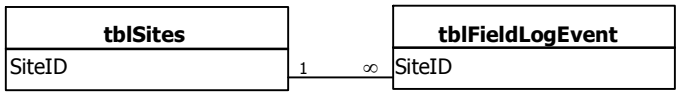
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

tblSitestblEventParticipants



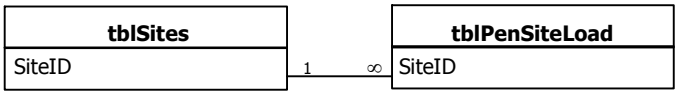
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

tblSitestblFieldLogEvent



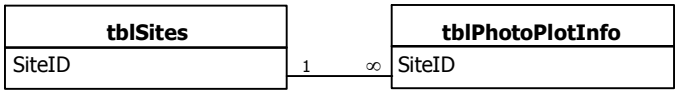
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

tblSitestblPenSiteLoad



Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

tblSitestblPhotoPlotInfo



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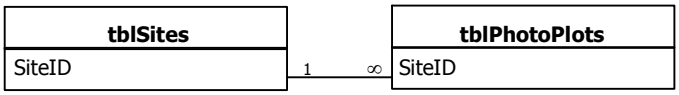

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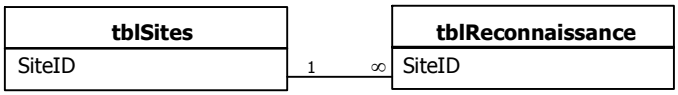

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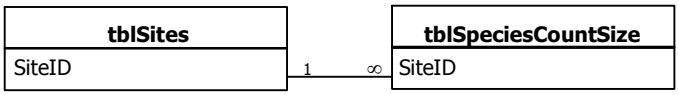

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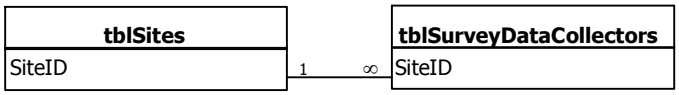

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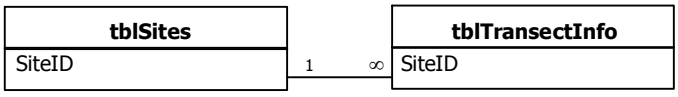

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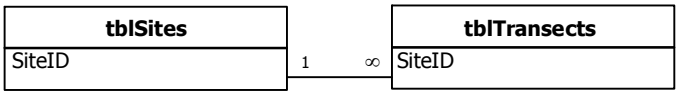

Attributes: Enforced, Cascade Updates
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Appendix E. Species Monitored: Target, Core, and Optional Species Defined

The definitions of monitored species are from the MARINe handbook (Engle 2005).

Target Species

"Target" species (also called key or indicator species) are species or species groups specifically chosen for long-term monitoring. They dominate particular zones or biotic assemblages in rocky intertidal habitats. The criteria for selecting target species include the following:

- Species that are ecologically important in structuring intertidal communities.
- Species that are competitive dominants or major predators.
- Species that are abundant, conspicuous, or large.
- Species whose presence provides numerous microhabitats for other organisms.
- Species that are slow growing and long lived.
- Species that have interesting distributions along California coasts.
- Species found throughout California shores.
- Species characteristic of discrete intertidal heights.
- Species that are rare, unique, or found only in a particular intertidal habitat.
- Species approaching their biogeographic limits in California.
- Species that have been well studied, with extensive literature available.
- Species of special human interest.
- Species vulnerable and/or sensitive to human impacts, especially from oil spills.
- Species with special legal status.
- Introduced or invasive species.
- Species harvested by sport or commercial activities.
- Practical species for long-term monitoring.
- Readily identifiable species.
- Sessile or sedentary species of reasonable size.
- Non-cryptic species.
- Species located high enough in the intertidal to permit sufficient time to sample.

Currently, there are **18 designated target species monitored by MARINe***: *Egregia menziezii, Fucus gardneri, Hedophyllum sessile, Hesperophycus californicus, Pelvetiopsis limitata, Silvetia compressa, Endocladia muricata, Neorhodomela larix, Phyllospadix scouleri/torreyi, Anthopleuraelegantissima/sola, Mytilus californianus, Lottia gigantea, Haliotis cracherodii, Chthamalus dalli/fissus/Balanus glandula, Semibalanus cariosus, Tetraclita rubescens, Pollicipes polymerus*, and *Pisaster ochraceus* (Table 1).
*underlined species are currently monitored at RNSP sites.

Designated target species have the highest priority for monitoring. They are monitored at as many sites as possible. If the species is present in sufficient numbers

and it is logistically possible, plots or transects are established to monitor it. Anywhere from 1 to 11 target assemblages are monitored at a given site. More information on target species (e.g., photos and how to identify) can be found on the MARINe public web site.

Core Species

"Core" species are those **species, species groups, or substrates that are scored using one or more survey methods by everyone in MARINe**. Core species must be reasonably and consistently identifiable using the designated scoring protocol (e.g., from lab scored photos of fixed plots possibly supplemented by plot sketches/notes). They also must be important enough to warrant scoring for abundance trends. Some of these species only occur at northern sites, or conversely, southern sites. However, to ensure that we notice if they expand their range, we must score everywhere. Table 2 provides the official list of core species. All target species (shown in bold on the table) are core species. It is important that **scorers in all monitoring groups be able to identify and record all core species. Datasheets must include all core species**, though core species that are absent or rarely occur at a site can be deemphasized. Entries for all core species will be required for data submission to the MARINe database. Definitions for core higher taxa and substrates are provided in Table 3.

Optional Species

"Optional" species are **non-core species or species groups that one or more monitoring groups choose to score at their sites; however, for various reasons, these species are not appropriate or feasible for all groups to score**. Since optional species will not be scored by everyone, regional comparisons of trends for these species will be limited or not possible.

Each monitoring group desiring to score optional species shall provide a list of these species to the MARINe data manager, along with mechanisms to translate optional species data to core species categories. For example, if choosing to monitor *Codium fragile*, you would submit the optional species data, which would be stored in the database as *Codium fragile*, but for standard regional comparisons of core species, would be lumped by the database to the next higher core species group "other green algae." **Choosing optional species requires a commitment to monitor the species consistently for a long period of time.** There is little value in scoring a species on an occasional basis (e.g., only when a particular person is available in the field to identify that species).

Table 1. Standardized names for target species plots.

Table 2. MARINe core species, higher taxa, and substrates.

Table 2. MARINe core species, higher taxa, and substrates (continued).

Definitions for Core Higher Taxa and Substrates

Articulated (Erect) Corallines: erect, jointed, calcified, red algae of the Family Corallinaceae, with flexible, articulate fronds arising from crustose bases.
Barnacles: adults or juveniles of any barnacle (Phylum Arthropoda, Class Crustacea, Subclass Cirripedia) species.
Chitons: adults or juveniles of any chiton (Phylum Mollusca, Class Polyplacophora) species.
Crustose (Encrusting) Corallines: thin, flattened, calcified, crust-like red algae of the Family Corallinaceae, having no erect, articulated fronds. Bleached crustose corallines (white) are scored as well because they may be alive.
Limpets: adults or juveniles of any limpet (Phylum Mollusca, Class Gastropoda, Family Acmaeidae) species, including *Lottia gigantea*.
Non-Coralline Crusts: any thin, flattened, crust-like red or brown algae that are not calcified species of the Family Corallinaceae.
Other Invertebrates (Other Animals): any invertebrates not listed or not identifiable in other more specific categories on the score sheet.
Other Barnacles: any barnacles not listed or not identifiable in other more specific categories on the score sheet.
Other Brown Algae: any brown algae not listed or not identifiable in other more specific categories on the score sheet (score "non-coralline crusts" separately).
Other Green Algae: any green algae not listed or not identifiable in other more specific categories on the score sheet.
Other Plant (Other Algae): any plants (algae) not listed or not identifiable in other more specific categories on the score sheet.
Other Red Algae: any red algae not listed or not identifiable in other more specific categories on the score sheet (score "non-coralline crusts" separately).
Rock (Bare Rock): bare, unconsolidated substrates larger than sand/gravel (including cobble, rocks, and boulders) and all consolidated substrates (e.g., bedrock) that contain no obvious living organisms or tar (epoxy corner markers and inconspicuous blue-green algal films are scored as "rock").
Sand: granular, particulate (fine sand to gravel) substrate. In photoplots, score "sand" unless you can positively identify what lies under the sand in the photo. In transects, score "sand" whenever sand cover is 2 cm or greater.
Tar: fresh or weathered oil or tar coating on the substrate.
Unidentified: cannot tell if plant, invertebrate, or substrate.

Literature Cited

Engle, J. M. 2005. Unified monitoring protocols for the Multi-Agency Rocky Intertidal Network (update). OCS Study MMS 05-01.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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